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ART. XIII.—*On the Destruction and partial Reproduction of Forests in British North America;* by JOHN WILLIAM DAWSON, Esq. of Pictou.*

THE changes produced by the agency of civilized man, in the condition of the earth's surface, and the numbers and distribution of its living inhabitants, though not of great importance when compared with those which result from the unceasing operation of natural causes, are interesting to the naturalist, as they illustrate the vicissitudes which many parts of the earth's surface have experienced in ancient times, the extent to which plants and animals can accommodate themselves to changes of circumstances, and the natural compensations which have been provided for the destruction or diminution of particular species. Inquiry into such changes is also of importance as a means of dispelling the mystery which frequently envelopes the succession of organized beings in circumstances of physical change; a mystery which has induced some naturalists to recur to the doctrine of spontaneous generation and the transmutation of species, for explanations of phenomena which if properly examined, would have been found to result from some of the most ordinary causes of the maintenance and distribution of animal and vegetable life.

In North America, and especially in those parts of it forming the United States and British Provinces, such changes have occurred with great rapidity, converting, in a few years, uninhabited forests into countries having the aspect of regions long inhabited

* From the Edinburgh New Philosophical Journal, April, 1847, vol. xlii, p. 259.

by civilized men. The forests have been destroyed, their living inhabitants extirpated or obliged to adopt new modes of life, new animals and plants introduced and naturalized; and, indeed, a revolution effected in all the departments of organized nature, in the lapse of a single generation. To notice a few of these changes, with reference more especially to the destruction and partial reproduction of forests, is my present object. The facts which I propose to state have been collected principally in the province of Nova Scotia.

In their natural state, Nova Scotia and the neighboring provinces were covered with dense woods, extending from the shores to the summits of the hills. These woods did not form detached groves, but constituted a nearly continuous sheet of foliage, the individual trees composing which were so closely placed as to prevent them from assuming full and rounded forms, and to oblige them to assume tall and slender shapes, that each might obtain air and light. The only exceptions to this are certain rich and usually light soils, where the forest is sometimes more open, and hills too rocky to support a covering of trees. When viewed from the summit of a hill, the forest presents a continuous undulating surface of a more or less dark color and uneven form, in proportion to the prevalence of the deep colors and uneven outlines of the evergreen coniferæ, or of the lighter tints and rounded contours of the deciduous trees; and these two classes are usually arranged in belts or irregular patches, containing mixtures of trees corresponding to the fertility and dryness of the soil. In general the deciduous or hardwood trees prevail on intervale ground, fertile uplands, and the flanks and summits of slaty and trappean hills; while swamps, the less fertile and lightest upland soils, and granitic hills, are chiefly occupied by coniferous trees.

The forest trees spring from a bed of black vegetable mould, whose surface is rendered uneven by the little hillocks of earth and stones thrown up by windfalls; and which, though usually named *Cradle hills*, are in reality the graves of departed members of the forest, whose trunks have mouldered into the mossy soil. These cradle hills are most numerous in thin soils; and are chiefly produced by the coniferous trees, and especially by the hemlock-spruce. There is usually little underwood in the original forest; mosses, lycopodia, ferns, and a few herbaceous flowering plants, however, flourish beneath the shade of the woods.

The woods perish by the axe and by fire, either purposely applied for their destruction or accidental. Forest fires have not been confined to the period of European occupation. The traditions of the Indians tell of extensive ancient conflagrations; and it is believed that some of the aboriginal names of places in Nova Scotia originated in these events. In later times, however, fires have been more numerous and destructive. In clearing land, the

trees when cut down are always burned, and, that this may be effected as completely as possible, the driest weather is frequently selected; although the fire then is much more likely to spread into the surrounding woods. It frequently happens that the woods contain large quantities of dry branches and tops of trees, left by cutters of timber and firewood, who rarely consider any part of the tree except the trunk worthy of their attention. Even without this preparation, however, the woods may in dry weather be easily inflamed; for although the trunks and foliage of growing trees are not very combustible, the mossy vegetable soil, much resembling peat, burns easily and rapidly. Upon this mossy soil depends, in a great measure, the propagation of fires, the only exception being when the burning of groves of the resinous coniferous trees is assisted by winds, causing the flame to stream through their tops more rapidly than it can pass along the ground. In such cases some of the grandest appearances ever shewn by forest fires, occur. The fire, spreading for a time along the ground, suddenly rushes up the tall resinous trees with a loud crashing report, and streams far beyond their summits, in columns and streamers of lurid flame. It frequently happens, however, that in wet or swampy ground, where the fire cannot spread around their roots, even the resinous trees refuse to burn; and thus swampy tracts are comparatively secure from fire. In addition to the causes of the progress of fires above referred to, it is probable that at a certain state of the growth of the forests, when the trees have attained to great ages, and are beginning to decay, they are more readily destroyed by accidental conflagrations. In this condition the trees are often much moss-grown, and have much dead and dry wood; and it is possible that we should regard fires arising from natural or accidental causes, as the ordinary and natural agents for the removal of such worn-out forests.

Where circumstances are favorable to their progress, forest fires may extend over great areas. The great fire which occurred in 1825, in the neighborhood of the Miramichi river, in New Brunswick, devastated a region one hundred miles in length and fifty miles in breadth. One hundred and sixty persons, and more than eight hundred cattle, besides innumerable wild animals, are said to have perished in this conflagration. In this case, a remarkably dry summer, a light soil easily affected by drought, and a forest composed of full-grown pine trees, concurred with other causes in producing a conflagration of unusual extent.

When the fire has passed through a portion of forest, if this consist principally of hardwood trees, they are usually merely scorched,—to such a degree, however, as in most cases to cause their death; some trees such as the birches, probably from the more inflammable nature of their outer bark, being more easily killed than others. Where the woods consist of softwood or co-

niferous trees, the fire often leaves nothing but bare trunks and branches, or at most a little foliage, scorched to a rusty-brown color. In either case, a vast quantity of wood remains unconsumed, and soon becomes sufficiently dry to furnish food for a new conflagration; so that the same portion of forest is liable to be repeatedly burned, until it becomes a bare and desolate "barren," with only a few charred and wasted trunks towering above the blackened surface. This has been the fate of large districts in Nova Scotia and the neighboring colonies; and as these burned tracts could not be immediately occupied for agricultural purposes, and are diminished in value by the loss of their timber, they have been left to the unaided efforts of nature to restore their original verdure. Before proceeding to consider more particularly the mode in which this restoration is effected, and the appearances by which it is accompanied, I may quote, from an article in a colonial periodical, the views of Mr. Titus Smith, secretary of the Board of Agriculture of Nova Scotia, on this subject. These views, as the results of long and careful observation, are entitled to much respect.

"If an acre or two be cut down in the midst of a forest, and then neglected, it will soon be occupied by a growth similar to that which was cut down; but when all the timber, on tracts of great size, is killed by fires, except certain parts of swamps, a very different growth springs up; at first a great number of herbs and shrubs, which did not grow on the land when covered by living wood. The turfy coat, filled with the decaying fibres of the roots of the trees and plants of the forest, now all killed by the fire, becomes a kind of hot-bed, and seeds which had lain dormant for centuries, spring up and flourish in the mellow soil. On the most barren portions, the blueberry appears almost everywhere; great fields of red raspberries and fire-weed or French willow, spring up along the edges of the beech and hemlock land, and abundance of redberried-elder and wild red-cherry appear soon after; but in a few years, the raspberries and most of the herbage disappear, and are followed by a growth of firs, white and yellow birch, and poplar. When a succession of fires has occurred, small shrubs occupy the barren, the Kalmia or sheep-poison being the most abundant; and, in the course of ten or twelve years form so much turf, that a thicket of small alder begins to grow, under the shelter of which fir, spruce, hacmetac (larch), and white birch spring up. When the ground is thoroughly shaded by a thicket twenty feet high, the species which originally occupied the ground begins to prevail, and suffocate the wood which sheltered it; and within sixty years, the land will generally be covered with a young growth of the same kind that it produced of old." Assuming the above statements to be a correct summary of the principal modes in which forests are reproduced, we may proceed to consider them more in detail.

1*st*, Where the wood is merely cut down and not burned, the same description of wood is immediately reproduced, and this may be easily accounted for. The soil contains abundance of the seeds of these trees; there are even numerous young plants ready to take the place of those which have been destroyed; and if the trees have been cut in winter, their stumps produce young shoots. Even in cases of this kind, however, a number of shrubs and herbaceous plants, not formerly growing in the place, spring up; the cause of this may be more properly noticed when describing cases of another kind. This simplest mode of the destruction of the forest, may assume another aspect. If the original wood have been of kinds requiring a fertile soil, such as maple or beech, and if this wood be removed, for example, for firewood, it may happen that the quantity of inorganic matter thus removed from the soil may incapacitate it, at least for a long time, from producing the same description of timber. In this case, some species requiring a less fertile soil may occupy the ground. For this reason, forests of beach growing on light soils, when removed for firewood, are some times succeeded by spruce and fir. I have observed instances of this kind, both in Nova Scotia and Prince Edward Island.

2*dly*, When the trees are burned, without the destruction of the whole of the vegetable soil, the woods are reproduced by a more complicated process, which may occupy a number of years. In its first stage, the burned ground bears a luxuriant crop of herbs and shrubs, which if it be fertile and not of very great extent, may nearly cover its surface in the summer succeeding the fire. This first growth may comprise a considerable variety of species, which we may divide into three groups. The first of these consists of herbaceous plants, which have their roots so deeply buried in the soil as to escape the effects of the fire. Of this kind, is a small species of Trillium, whose tubers are deeply imbedded in the black mould of the woods, and whose flowers may sometimes be seen thickly sprinkled over the black surface of woodland very recently burned. Some species of ferns, also in this way, occasionally survive forest fires. A second group is composed of plants whose seeds are readily transported by the wind. Of this kind, is the species of Epilobium, known in Nova Scotia as the fire-weed or French willow, whose feathered seeds are admirably adapted for flying to great distances, and which often covers large tracts of burned ground so completely, that its purple flowers communicate their own color to the whole surface, when viewed from a distance. This plant appears to prefer the less fertile soils, and the name of fire-weed has been given to it, in consequence of its occupying these when their wood has been destroyed by fire. Various species of Solidago and Aster, and other composite plants, and Ferns, Lycopodia, and

Mosses, are also among the first occupants of burned ground, and their presence may be explained in the same way with that of Epilobium; their seeds and sporules being easily scattered over the surface of the barren by wind. A third group of species, found abundantly on burned ground, consists of plants bearing edible fruits. The seeds of these are scattered over the barren by birds which feed on the fruits, and finding a rich and congenial soil, soon bear abundantly and attract more birds, bringing with them the seeds of other species. In this way it sometimes happens that a patch of burned ground, only a few acres in extent, may, in a few years, contain specimens of nearly all the fruit-bearing shrubs and herbs indigenous in the country. Among the most common plants which overspread the burned ground in this manner, are the raspberry, which, in good soils, is one of the first to make its appearance; two species of vaccinium, called in Nova Scotia, blueberries; the tea-berry wintergreen (*Gaultheria procumbens*); the pigeon-berry (*Cornus canadensis*); and the wild strawberry. It is not denied that some plants may be found in recently burned districts, whose presence may not be explicable in the above modes; but no person acquainted with the facts, can deny that all the plants which appear, in any considerable quantity, within a few years after the occurrence of a fire, may readily be included in the groups which have been mentioned. By the simple means which have been described, a clothing of vegetation is speedily furnished to the burned district; the unsightliness of its appearance is thus removed, abundant supplies of food are furnished to a great variety of animals, and the fertility of the soil is preserved, until a new forest has time to overspread it.

With the smaller plants which first cover a burned district, great numbers of seedling trees spring up, and these, though for a few years not very conspicuous, eventually overtop, and, if numerous, suffocate the humbler vegetation. Many of these young trees are of the species which composed the original wood, but the majority are usually different from the former occupants of the soil. The original forest may have consisted of white or red pine; black, white, or hemlock spruce; maple, beech, black or yellow birch, or of other trees of large dimensions, and capable of attaining to a great age. The "second growth" which succeeds these, usually consists of poplar, white or poplar birch, wild cherry, balsam fir, scrub pine, alder, and other trees of small stature, and usually of rapid growth, which, in good soils, prepare the way for the larger forest trees, and occupy permanently, only the less fertile soils. A few examples will show the contrast which thus appears between the primeval forest and that which succeeds it after a fire. Near the town of Pictou, woods chiefly consisting of beech, maple, and hemlock, have been succeeded

by white birch and firs. A small clearing in woods of maple and beech in New Annan, which, thirty years ago, was under cultivation, is now thickly covered with poplars thirty feet in height. In Prince Edward Island, fine hardwood forests have been succeeded by fir and spruce. The pine woods of Miramichi, destroyed by the great fire above referred to, have been followed by a second growth, principally composed of white birch, poplar, and wild cherry. When I visited this place, a few years since, the second growth had attained to nearly half the height of the dead trunks of the ancient pines, which were still standing in great numbers.

As already stated, the second growth almost always includes many trees similar to those which preceded it, and when the smaller trees have attained their full height, these and other trees capable of attaining a greater magnitude, overtop them, and finally cause their death. The forest has then attained its last stage, that of perfect renovation. The cause of the last part of the process evidently is, that in an old forest, trees of the largest size and longest life have a tendency to prevail, to the exclusion of others. For reasons which will be afterwards stated, this last stage is rarely attained by the burned forests, in countries beginning to be occupied by civilized man.

In accounting for the presence of the seeds necessary for the production of the second growth, we may refer to the same causes which supply the seeds of the smaller plants appearing immediately after the fire. The seeds of many forest trees, especially the poplar, the birch, and the firs, and spruces, are furnished with ample means for their conveyance through the air. The cottony pappus of the poplar seems especially to adapt it for this purpose. The seeds of the wild cherry, another species of frequent occurrence in woods of the second growth, are dispersed by birds, which are fond of the fruit; the same remark applies to some other fruit-bearing species of less frequent occurrence. When the seeds that are dispersed in these ways fall in the growing woods, they cannot vegetate, but when they are deposited on the comparatively bare surface of a barren, they readily grow; and if the soil be suited to them, the young plants increase in size with great rapidity.

It is possible, however, that the seeds of the trees of the second growth may be already in the soil. It has been already stated that deeply buried tubers sometimes escape the effects of fire, and, in the same manner, seeds imbedded in the vegetable mould, or buried in cradle hills, may retain their vitality, and being supplied by the ashes which cover the ground, with alkaline solutions well-fitted to promote their vegetation, may spring up before a supply of seed could be furnished from any extraneous source. It is even probable that many of the old forests may

already have passed through a rotation similar to that above detailed, and that the seeds deposited by former preparatory growths may retain their vitality, and be called into life by the favorable conditions existing after a fire. This is a point, however, requiring for its establishment a series of experiments which I have not yet been able to undertake.

If, as already suggested, forest fires, in the uncultivated state of the country, be a provision for removing old and decayed forests, then such changes as those above detailed, must have an important use in the economy of nature, since by their means different portions of the country would succeed each other in assuming the state of "barrens," producing an abundance of herbs and wild fruits suitable for the sustenance of animals which could not subsist in the old forests; and these gradually becoming wooded, would keep up a succession of young and vigorous forests.

3*dly*, The progress of restoration may be interrupted by successive fires. These are most likely to occur soon after the first burning, but may happen at any subsequent stage. The resources of nature are not, however, easily exhausted. When fires pass through young woods some trees always escape; and so long as any vegetable soil remains, young plants continue to spring up, though not so plentifully as at first. Repeated fires, however, greatly impoverish the soil, since the most valuable part of the ashes is readily removed by rains, and the vegetable mould is entirely consumed. In this case, if the ground be not of great natural fertility, it becomes incapable of supporting a vigorous crop of young trees. It is then permanently occupied by shrubs and herbaceous plants; at least these remain in exclusive possession of the soil for a long period. In this state the burned ground is usually considered a permanent barren; a name which does not, however, well express its character, for though it may appear bleak and desolate when viewed from a distance, it is a perfect garden of flowering and fruit-bearing plants, and of beautiful mosses and lichens. There are few persons born in the American colonies, who cannot recall the memory of happy youthful days spent in gathering flowers and berries in the burnt barrens. Most of the plants already referred to as appearing soon after fires, continue to grow in these more permanent barrens. In addition to these, however, a great variety of other plants gradually appear, especially the Kalmia angustifolia or sheep laurel, which often becomes the predominant plant over large tracts. Cattle straying into barrens deposit the seeds of cultivated plants, as the grasses and clovers, as well as of many exotic weeds, which often grow as luxuriantly as any of the native plants.

Lastly, When the ground is permanently occupied for agricultural purposes, the reproduction of the forest is of course entirely prevented. In this case, the greater number of the smaller plants found in the barrens disappear. Some species of the Solidago and Aster, and the Canada thistle, as well as a few smaller plants, remain in the fields, and sometimes become troublesome weeds. The most injurious weeds found in the cultivated ground, are not, however, native plants, but foreign species, which have been introduced with the cultivated grains and grasses; the ox-eyed daisy or white weed, and the crowsfoot or buttercup, are two of the most abundant of these.

When a district has undergone the last change, when the sombre woods and the shade-loving plants that grow beneath them, have given place to open fields, clothed with cultivated plants, the metamorphosis which has taken place extends in its effects to the indigenous animals; and in this department, its effects are nearly as conspicuous and important as in relation to vegetation. Some wild animals are incapable of accommodating themselves to the change of circumstances; others at once adapt themselves to new modes of life, and increase greatly in numbers. It was before stated that the barrens, when clothed with shrubs, young trees, and herbaceous plants, were in a condition highly favorable to the support of wild animals; and perhaps there are few species which could not subsist more easily in a country at least partially in this state. For this reason, the transition of a country from the forest state to that of burned barrens is temporarily favorable to many species, which disappear before the progress of cultivation; and this would be more evident than it is, if European colonization did not tend to produce a more destructive warfare against such species than could be carried on by the Aborigines. The ruffed grouse, a truly woodland bird, becomes, when unmolested, more numerous on the margins of barrens and clearings than in other parts of the woods. The hare multiplies exceedingly in young second growths of birch. The wild pigeon has its favorite resort in the barrens during a great part of the summer. The moose and cariboo, in summer, find better supplies of food in second growth and barrens than in the old forests. The large quantities of decaying wood, left by fires and wood-cutters, afford more abundant means of subsistence to the tribe of woodpeckers. Many of the fly-catchers, warblers, thrushes, and sparrows, greatly prefer the barrens to most other places. Carnivorous birds and quadrupeds are found in such places in numbers proportioned to the supplies of food which they afford. The number of instances of this kind might be increased to a great extent if necessary; enough has, however, been stated to illustrate the fact.

Nearly all the animals above noticed, and many others, disappear when the country becomes cultivated. There are, however, other species which increase in numbers and at once adapt themselves to the new conditions introduced by man. The robin (Turdus migratorius) resorts to and derives its subsistence from the fields, and greatly multiplies, though much persecuted by sportsmen. The Fringilla nivalis, a summer bird in Nova Scotia, becomes very familiar, building in out-houses, and frequenting barns in search of food. The song sparrow and Savannah finch, swarm in the cultivated ground. The yellow bird (Sylvia æstiva) becomes very familiar, often building in gardens. The golden-winged woodpecker resorts to the cultivated fields, picking grubs and worms from the ground. The cliff-swallow exchanges the faces of rocks for the eaves of barns and houses, and the barn and chimney swallows are everywhere ready to avail themselves of the accommodation afforded by buildings. The acadian or little owl makes its abode in barns during winter. The bob-lincoln, the king bird, the waxwing or cherry bird, and the humming bird, are among the species which profit by the progress of cultivation. The larger quadrupeds disappear, but the fox and ermine still prowl about the cultivated grounds, and the field-mouse (Arvicola Pennsylvanica) which is very abundant in some parts of the woods, is equally so in the fields. Many insects are vastly increased in numbers, in consequence of the clearing of the forests. Of this kind are the grasshoppers and locusts, which, in dry seasons, are very destructive to grass and grain; the frog-spittle insects (Cercopis) of which several species are found in the fields and gardens, and are very injurious to vegetation; and the lepidoptera, nearly the whole of which find greater abundance of food and more favorable conditions in the burned barrens and cultivated fields, than in the growing woods. It may be remarked, in general, that there is no animal, frequenting in Europe the cultivated grounds, and either beneficial or noxious to man, which has not, in the indigenous species of America, an exact representative, filling its place in the economy of nature, and often, in a natural historical point of view, closely related to it. This results from the general sameness of arrangement in the system of nature in the old and new world; and if studied in its details, would form a subject of great interest to the zoologist and physical geographer.

Art. XIV.—*Review of the Organic Chemistry of* M. Charles Gerhardt.

(Concluded from p. 100.)

We have already seen that M. Gerhardt halves the equivalents of most substances, taking the equivalent of hydrogen to be represented by the weight of its atom. Chlorine, bromine and iodine which unite with hydrogen, volume for volume, are also divided so that their volumes correspond to that of oxygen. In many reactions in which carbonic acid and water are evolved, they are observed to be in the proportions $C_2 O_4$ and $H_4 O_2$, or in quantities double those which are regarded as equivalents in mineral chemistry. It will also be observed that in the formulas of all those substances which like alcohol and its derivatives are ordinarily represented by four volumes of vapor, the equivalents of carbon and oxygen are divisible by two and those of hydrogen by four. This has led many chemists to consider the oxygen in organic compounds as having double the equivalent ascribed to it in mineral combinations. If we regard $C_2 O_4$ and $H_4 O_2$ as representing single equivalents, it will then be necessary to double the formulas of mineral chemistry in order to harmonize the two. If on the other hand these represent two equivalents, the formulas of organic compounds must be divided; and this last course has been adopted by M. Gerhardt.

The protoxyds of the metals corresponding to water in their composition, will hence be expressed by $M_2 O$, and the equivalents of metals themselves will be one-half the number usually adopted. The equivalents of organic acids are generally determined from their silver salts, and in the monobasic acids the weight corresponding to one atom of silver is taken as the equivalent of the salt; thus the acetic acid is $C_2 H_4 O_2$, and the acetate of silver $C_2 (H_3 Ag) O_2$, in which it is impossible to imagine the existence of water or oxyd of silver, which are $H_2 O$ and $Ag_2 O$.

The equivalents of chlorine, bromine and iodine, will by this arrangement, be like oxygen represented by a single volume; those of nitrogen, phosphorus and arsenic, are also divided, while carbon with sulphur and selenium are retained unaltered. The equivalent of water is represented by $H_2 O$ and equals two volumes of vapor, hydrochloric acid is $HCl = 2$ vol. vapor, and ammonia in like manner is $N H_3$ and its equivalent is expressed by two volumes.—(Précis, Vol. I, pp. 47–53.)

Mode of Combination.—Many compounds have the power of exchanging one or more of their equivalents of hydrogen for a metal, thus producing a series of compounds known as salts. All of those metals which unite with chlorine in single equivalents,

are able to exchange themselves for hydrogen, equivalent for equivalent. The acids are then to be regarded as salts of hydrogen, and the view which regards them as compounds of an anhydrous acid with water, is inadmissible, as the monobasic acids contain but one equivalent of hydrogen, which is replaced by a metal, while water contains two equivalents of that element. A second mode of combination is that designated by title of *metalepsis* or equivalent substitution. In these as in the salt compounds, certain elements are capable of being replaced by others, without altering the molecular constitution of the organic substance. The phenomena of metalepsis are divided into two classes, those in which hydrogen is replaced by chlorine, bromine or iodine, and those where oxygen is exchanged for sulphur, selenium or tellurium. The two metaleptic groups are illustrated by the following examples.

Metalepsis of Hydrogen.

$C\,H_4$ Formene, (marsh gas.)
$C\,(H_3\,Cl)$ Chlorinized formene, (chlorid of methyle.)
$C\,(H_3\,Br)$ Brominized formene, (bromid of methyle.)
$C\,(H_3\,I)$ Iodized formene, (iodid of methyle.)
$C\,(H_2\,Cl_2)$ Bichlorinized formene.
$C\,(HCl_3)$ Trichlorinized formene, (chloroform.)
CCl_4 Quadrichlorinized formene, (chlorid of carbon.)
$C_2\,H_4\,O_2$ Normal acetate, (acetic acid.)
$C_2\,(HCl_2)\,O_2$ Trichlorinized acetate, (chloracetic acid.)

Metalepsis of Oxygen.

$C_4\,H_{10}\,O$ Ether, (sulphuric ether.)
$C_4\,H_{10}\,S$ Sulphuretted ether, (sulphuret of ethyle.)
$C_4\,H_{10}\,Se$ Seleniuretted ether, (seleniuret of ethyle.)
$C_4\,H_{10}\,Te$ Telluretted ether, (telluret of ethyle.)

In these reactions the substitutions are always equivalent, and since one equivalent of chlorine corresponds to one of hydrogen, and one of oxygen to two of hydrogen, it follows that oxygen cannot like chlorine replace hydrogen.

The metaleptic hydrogen is to be carefully distinguished from that which is replaceable by a metal. The action of chlorine upon acetic acid, removes three equivalents of its hydrogen and substitutes three of chlorine in their place, forming chloracetic acid $C_2\,(HCl_2)\,O_2$, but the fourth equivalent can only be removed by substituting a metal in its place.

Substitution of Residues.—The action of nitric acid upon many organic substances, results in the formation of water and a new compound which contains the elements of the acid; thus benzene $C_6\,H_6$, with nitric acid NHO_3 forms an equivalent of water and the new substance $C_6\,H_5\,NO_4$. In this and analogous com-

pounds, NO_2 has been viewed as replacing one equivalent of hydrogen in the organic body, but a more extended examination has led to the establishment of the following principle. "The hydrogen of one of the bodies unites with the oxygen of the other to form water and the remaining elements are left in combination." The action of nitric acid and benzene may then be thus represented.

$(C_6 H_6 - H_2) + (NHO_3 - O) = C_6 H_4 NHO_2$ and $H_2 O$.

The residue NHO_2 replaces H_2 in the compound.

To distinguish this phenomenon from metalepsis, M. Gerhardt designates it as *accouplement* and the compounds thus formed as *coupled bodies*. This beautiful law admits of a very extended application, and renders useless the various hypothetical radicals which have been assumed to explain the different reactions of organic compounds.

Another class of combinations are those formed by the direct union of two bodies, of which we have examples in the complication of two molecules of the oil of bitter almonds to form one of benzoine; chlorine and hydrochloric acid also unite directly with many essential oils, and the salts of ammonia and the organic alkaloids are examples of the same class of compounds. The application of these principles to different classes of products will be considered farther on.—(Précis, Vol. I, pp. 58–66.)

These changes in the view of the composition of bodies necessarily require some change in nomenclature. Our present system was a grand and beautiful conception worthy of the genius of its framers, and undoubtedly more complete in its plan and its capability of extension than that of any other science. But since it involves in its names of salts the idea that they contain hydrogen in the state of water and metals as oxyds, a theory which is now no longer admissible, some alteration has become necessary. The principle that the name of the compound should express its composition, which is one of the most important features of the old system, is still retained, and the name of the typical substance is the designation of a genus of which the bodies derived from it by replacements, are species to which the binomial nomenclature of Linnæus is applied. The type of the genus is that which contains only the organic elements, and is designated as the *normal species*.

Species of the genus Acetate.

Normal Acetate,	(Acetic acid,)	$C_2 H_4 O_2$.
Potassic do.	(Acetate of potash,)	$C_2 (H_3 K) O_2$.
Argentic do.	(Acetate of silver,)	$C_2 (H_3 Ag) O_2$.
Trichlorinzed do.	(Chloracetic acid,)	$C_2 (Cl_3 H) O_2$.
Trichloro-potassic do.	(Chloracetate of potash,)	$C_2 (Cl_3 K) O_2$.
Trichloro-argentic do.	(Chloracetate of silver,)	$C_2 (Cl_3 Ag) O_2$.

The terminations in *ate* and *uret* are restricted to saline combinations; the hydrocarbons have their ending in *ene;* the oxygenized volatile liquids, like the alcohols and essential oils, in *ol;* and the alkaloids in *ine.*

The second part of the work is devoted to a consideration of the characters of the several classes of organic substances. The salts as among the most important compounds are first noticed; under this title are included the acids (salts of hydrogen) with their derivations, the coupled acids and the various sesquisalts and emetics. An acid may be characterized as a compound which can exchange one or more equivalents of its hydrogen for a metal, and which unites with alcohol to form an ether, with the separation of the elements of water. We know at present those which are capable of exchanging one, two or three equivalents of their hydrogen, constituting monobasic, bibasic, and tribasic salts. The terms bibasic and tribasic are often applied to the compounds of neutral monobasic salts with certain metallic oxyds; the acetate of lead unites with two equivalents of oxyd of lead to form the salts known as the *tribasic acetate;* in this but one equivalent of hydrogen is replaced by the metal, and the two equivalents of oxyd are but feebly united, performing perhaps a function analogous to water of crystallization. Such as these M. Gerhardt conveniently distinguishes as *surbasic salts;* and the compound just noticed, which is $C_2 (H_3 Pb) O_2 + Pb_2 O$, will then be the *bisurbasic acetate.*

The action of the oxyds of the formula $M_2 O$ with acids results in the formation of neutral salts, and the elimination of the elements of water, which is formed from the union of the oxygen of the oxyd with the hydrogen of two equivalents of the acid. The oxyds of the form $M_4 O_3$, as the sesquioxyd of iron, unite in the same manner with the separation of the elements of water, but their three equivalents of oxygen form water with the replaceable hydrogen of six equivalents of the acid, and the residue which replaces this is equal to only four equivalents. Thus $6C_2 H_4 O_2 + Fe_4 O_3 = 3H_2 O + C_{12} H_{18} Fe_4 O_{12}$. If we would represent this substitution as equivalent, $Fe_{\frac{3}{2}}$ designated as $Fe^{\beta} = H$, then the peracetate of iron is $C_2 H_3 Fe^{\beta} O_2$.

In the same manner the sesquioxyd of antimony $Sb_2 O_3$ and arsenious acid $As_2 O_3$ unite with the bibasic acids and form compounds in which Sb_2 is substituted for H_6 or $Sb_{\frac{3}{2}}$ represented by our author as $Sb^{\alpha} = H$. Tartar emetic is an instance of this class of compounds; when the acid, tartrate of potash, is boiled with sesquioxyd of antimony it dissolves, and on cooling, a salt separates, which is $C_4 H_4 KSb O_7 Aq$. It is formed from $2C_4 H_5 KO_6 + Sb_2 O_3 = 2C_4 H_4 KSbO_7 + H_2 O$. The oxyd

here loses but one equivalent of its oxygen, and it is the residue $Sb_2O_2 = Sb_2O_3 - O$ which replaces H_2; we may represent SbO by $Sb^{\circ} = H$, and the composition of the salt is then $C_4H_4KSb^{\circ}O_6 + Aq$, while that of tartaric acid is $C_4H_6O_6$. At a temperature of 212° F. the combined water is expelled and at 428° F. the equivalent of oxygen which we have considered as existing in Sb° unites with two equivalents of the hydrogen and is evolved in the form of water; the reduction of the oxyd is now complete and a new salt results, which is $C_4H_2KSbO_6$, or as according to the notation of M. Gerhardt, the equivalent of antimony replacing hydrogen is $Sb_{\frac{1}{3}} = Sb^{\alpha}$, it is $C_4H_2KSb^{\alpha}_3O_6$. The oxyd of uranium is analogous in constitution to that of antimony, and M. Peligot has obtained a double tartrate of antimony and uranium, which, dried at 212° contains $C_4(H_4U^{'}Sb^{\circ})O_6$; at 392°, a decomposition similar to that of tartar emetic takes place, and the whole of the hydrogen is expelled in the form of water, the residue contains $C_4USbO_6 = C_4U^{\alpha}_3Sb^{\alpha}_3O_6$. Arsenious and boracic acids form with cream of tartar double salts, analogous to tartar emetic and undergoing a similar decomposition by heat.—(Précis, Vol. I, pp. 498–502.)

These singular compounds are so far removed in many of their characters from ordinary saline compounds, that it is difficult to say in what view we are to regard them.

The use of symbols to denote the forms in which the metal replaces the hydrogen is merely for the purpose of illustration. To regard these as really equivalent substitutions would be to adopt a principle which would involve much perplexity and confusion in other cases, and it is better to view them, as in truth, substitutions by residue, in which the idea of metaleptic substitution is not necessarily implied. The metal in them is frequently no longer recognizable by the ordinary tests; thus in tartar emetic the antimony is not precipitable by alkalies, and the power of the tartaric and many other polybasic vegetable acids to prevent the precipitation of iron and alumina by ammonia is well known. The oxalate of chrome and potash is but partially decomposed either by potash or salts of lime. It is worthy of notice that the volatile acids, a portion of whose hydrogen is metaleptic or replaceable by chlorine, do not like the tartaric acid form compounds in which M^{α} is substituted for the hydrogen.

The number of equivalents of oxygen in an acid bears a certain relation to its basicity. A monobasic acid may contain two, three, or four equivalents, a bibasic acid from four to eight, and a tribasic acid six or seven; two, four, and six being the minima

of oxygen found in the three classes. When a monobasic acid is exposed to the joint action of heat and of a basic oxyd, as of lime or baryta, it loses one equivalent of carbonic acid, and is transformed into a compound which is either a hydro-carbon like benzene, or a neutral oxygenized substance like phenol. This same decomposition is often effected by heat alone, as when the vapor is passed through an ignited tube. The bibasic acids under the influence of heat, lose one or two equivalents of carbonic acid, yielding in the one case monobasic acids, and in the other neutral compounds like the previous class, which result perhaps from the decomposition of the acids previously formed. Tribasic acids in the same manner yield one equivalent of carbonic acid, and a bibasic acid or two, and monobasic and perhaps a neutral compound, with the elimination of three of carbonic acid. In many of these reactions a portion of the oxygen and hydrogen is also disengaged in the form of water.—(Précis, Vol. I, pp. 78–80.)

The solubility of acids in water bears a certain relation to their equivalents and to the amount of oxygen which they contain; in those containing atomically the same proportions it is inversely as their equivalent; this is well illustrated by the class of acids mentioned on page 99. When the carbon is the same, the solubility increases with the amount of oxygen; for example, the tannic, coumaric, and cinnamic acids each contain $C_9 H_8$; while the amount of oxygen is respectively six, three, and two equivalents. The tannic is very soluble in water, the coumaric slightly so, and the cinnamic least of all. Similar relations are to be observed in neutral bodies, and very often guide us in the examination of new and unknown substances.

Coupled Salts.—We have already explained our author's use of the term accouplement to describe certain combinations in which an acid unites with an organic substance with the separation of the elements of water, and forms a compound in which the peculiar properties of neither of its components are recognizable. Those formed by a monobasic acid are neutral, but if the acid is polybasic and combines with but one equivalent of the organic substance, the result is a *coupled acid*. Sulphuric acid unites in this way with almost all organic substances; with alcohol it forms the sulpho-vinic acid; it combines with the hydrocarbons, as napthaline and benzene, with sugar and starch, with azotized bodies like indigo, and with acids, as the acetic and succinic. Analysis demonstrates that these combinations contain the elements of one equivalent of organic matter, and one of sulphuric acid minus the elements of one equivalent of water.

The baryta salts of all these acids are soluble in water and frequently in alcohol. The acids produced by the accouplement of neutral substances with sulphuric acid are monobasic; those formed with a monobasic acid, as the acetic, are bibasic;

while those, like the sulpho-succinic, derived from the bibasic acid, are tribasic. The sulphuric acid is bibasic,* and from these facts we deduce the law, that the basicity or capacity of saturation in a coupled salt is always less by one than the sum of the basicities of its components. Thus sulpho-vinic acid is formed from one equivalent of a bibasic acid and one of alcohol, which is neutral, and is monobasic $(2+0)-0=1$. The sulpho-succinic is derived from two bibasic acids and is tribasic, $(2+2)-1=3$. This law is applicable to all cases of accouplement. The phosphoric acid, which is tribasic, unites with alcohol to form a bibasic acid. Similar coupled acids are formed by oxalic, carbonic, tartaric acids and others with the alcohols.

The couples of sulphuric acids are often found by the simple mixture of the two bodies, but with the hydro-carbons of a high equivalent it is necessary to dissolve them in the fuming acid or expose them to the vapor of anhydrous sulphuric acid, and then heat the product with water; in this way the sulpho-acetic acid was formed by Melsens. The lime and baryta salts of all these acids are soluble in water, although the sulphates of these bases are quite insoluble.—(Précis, pp. 98–104.)

The nitric acid being monobasic does not form coupled acids with neutral bodies like alcohol, but its action upon monobasic acids yields a series of azotized acids which are themselves monobasic as $(1+1)-1=1$. The benzoic acid, when boiled for some time with strong nitric acid, yields the *nitrobenzoic*, which contains the elements of one equivalent of each of the acids *minus* one equivalent of water, $C_7H_6O_2+NHO_3=C_7H_5NO_4+H_2O$. The residue of the nitric acid $NHO_3-O=NHO_2$ must be regarded as replacing H_2 in the acid; which is consequently $C_7(H_4NHO_2)O_2$; it is scarcely distinguished from normal benzoic acid in its characters. These acids and their salts are characterized by exploding when suddenly heated. The action of nitric acid upon phenol gives rise to a curious azotized compound described at different times as the *bitter principle of Welter*, carbazotic, picric, nitro-picric and nitro-phenisic acids. It is the final product of the action of nitric acid upon indigo, salicine and many other bodies, but is directly formed from phenol by the same process. Its formula is $C_6H_3N_3O_7$, while phenol is C_6H_6O, and it is derived from this by the complete replacement of its hydrogen by the residue of nitric acid; it may be represented by $C_6(NHO_2)_3=O$; the strongest nitric acid is totally without action upon it.

* Although the sulphuric acid is generally regarded as monobasic, the existence of double and acid salts, and its reactions with organic substances, clearly show that it is a bibasic acid. In these respects it is strikingly contrasted with the nitric acid, which is truly monobasic, forms no acid or double salts, and yields only neutral couples with organic bodies.

Anhydrides.—Many organic acids by the action of heat, lose the elements of water and are converted into substances which in accordance with the theory which regarded the acids as compounds of a dry acid with water, have been styled anhydrous acids. These substances are neutral in their reaction and their solutions have no action upon alkaline carbonates, but when long boiled with water they take up the elements of that liquid and regenerate acids. The acids thus obtained often differ in their properties from the originals; this has been particularly observed of the anhydrides of camphoric and itaconic acids.—(Précis, Vol. I, pp. 106–109.)

The anhydrides formed by the action of heat alone, are those of certain bibasic acids which lose their basic hydrogen in the form of water. Some monobasic acids as the stearic and margaric are decomposed by distillation with anhydrous phosphoric acid and yield neutral fatty substances; but in these the acid loses two equivalents of hydrogen of which only one is basic; the type is hence destroyed and the acid cannot be regenerated from them.

In this class we may conveniently consider all those compounds which under certain circumstances assume the elements of water and form acids. Isatine when dissolved in a solution of potash, in this way generates an isatate, and when this acid is set free, it is decomposed by a gentle heat into isatiric acid and water. Camphor also when heated with hydrate of potash yields campholic acid which is formed by the union of the elements of water; according to the general idea both camphor and isatine are anhydrous acids.

Amides.—Few subjects have been the cause of more perplexity to chemists that the action of ammonia with organic substances. M. Dumas first observed in the products of the dry distillation of oxalate of ammonia, a white insoluble body to which he gave the name of *oxamide*. It is derived from oxalate of ammonia by the abstraction of the elements of water; $C_2 H_4 O_4 + 2NH_3 = C_2 H_4 N_2 O_2 + 2H_2 O$, and by the action of acids or alkalies reassumes them and regenerates the oxalate and ammonia. When ammonia is added to a solution of chlorid of mercury, hydrochloric acid is set free and forms salammoniac while a white precipitate falls which is $Hg_2 NH_2$; this may be received as a compound of chlorid of mercury with $Hg NH_2$. The residue of the ammonia NH_2 was hence conceived to be compound radical analogous to chlorine in its reactions, to which the name of *amide* or *amidogen* was given, and oxamide was regarded as an amide of CO, the assumed base of oxalic acid, $C_2 H_4 N_2 O_2 = 2(CO + NH_2)$. Subsequently M. Laurent was induced to imagine another radical NH which he called *imide*, and which he viewed as existing in many organic compounds sustaining the

same relations as amide. Oxamide itself, might be viewed as containing this substance. The ammonia gives two equivalents of its hydrogen to combine with the oxygen of the organic substance. Thus $C_2 H_2 O_2 + 2 NH$. In other cases the whole of the hydrogen of the ammonia is eliminated in the form of water, and N alone remains combined with the residue. Three equivalents of bitter almond oil and two of ammonia form one of hydrobenzamide with the solution of three of water, $3 C_7 H_6 O + 2 NH_3 = C_{21} H_{18} N_2 + 3 H_2 O$. As N_2 here replaces O_3, MM. Millon and Bineau have been induced to consider the equivalent of nitrogen as two-thirds of the number generally adopted. The explanation of all these difficulties is found in the fact that according to the nature of the organic substances, ammonia loses one, two or three equivalents of its hydrogen and leaves NH_2, NH or N only in combination.

The amides of the monobasic acids are derived from one equivalent of the acid and one of ammonia by the elimination of $H_2 O$; thus benzoic acid, $C_7 H_6 O_2$ and $NH_3 =$ benzamide $C_7 H_7 NO + H_2 O$. The amides of the bibasic acids are formed in the same manner from one equivalent of acid and two of ammonia by the elimination of two of water. When but one equivalent of ammonia enters into the reaction, an acid amide is obtained which may be regarded as analogous to the coupled acids already described, (p. 176.) The acid oxalate of ammonia $C_2 H_2 O_2$, NH_3 affords *oxamic acid* $C_2 H_3 NO_3 + H_2 O$. These acids are monobasic in accordance with the law before given; $(2+O)-1=1$. When they or their salts are placed in contact with acids or an excess of caustic potash, they resume the elements of water and regenerate the acid and ammonia. The same change takes place when the acids are long boiled with water.

The amides of some of the bibasic acids are formed in decomposing the ammoniacal salts by heat, and the amides of the other acids may be obtained by the action of ammonia upon their ethers, a process which will be again noticed. Some anhydrides like succinide and isatine combine with ammonia with the evolution of water and the formation of a new amide. That of succinide is called *succinidam;* it is neutral and contains the elements of one equivalent of ammonia and one of succinic acid *minus* $3 H_2 O$; by the action of alkalies it regenerates succinic acid and ammonia. The number of amides which may be derived from a single substance is often very great.* The amide acids themselves may form amides; asparagine is the amide of aspartic acid, and when boiled with an alkali takes up $H_2 O$ and loses ammonia forming aspartic acid, which is itself an amide. By the aid of

* For a notice of the amides of phosphoric acid, the reader is referred to this Journal, ii Series, vol. iii, No. 7, p. 105.

certain ferments, asparagine is completely converted into succinate of ammonia.

The compounds like succinidam which differ from ordinary amides by the elements of water are designated by M. Gerhardt as *hydride amides;* they often present acid characters. Prussic acid is anhydride amide of formic acid, in other words the amide of formic anhydride which is carbonic oxyd CO. When formate of ammonia is heated it is directly resolved into this acid and water $CH_2O, NH_3 = 2H_2O + CHN$; and when prussic acid is mixed with strong acids, or when its salts are boiled with alkalies, it reassumes the elements of water and regenerates a formate and ammonia. The cyanic acid is the amide of carbonic anhydride (carbonic acid gas), and like the other amides, regenerates ammonia and the acid under the influence of acids and alkalies. A large number of azotized acids are included in this class.—(Précis, Vol. I, pp. 110–120.)

Ethers.—These are compounds resulting from the action of mineral and organic acids upon the alcohols, and like the amides contain the elements of both their constituents *minus* the elements of water. Those of the monobasic acids are formed from one equivalent of the alcohol and one of the acid, by the abstraction of the elements of one equivalent of water. The ethers of the bibasic acids are in a similar manner produced by their reaction upon two equivalents of alcohol. In accordance with the theory of compound radicals, they are regarded as salts of the oxyd of a radical which is derived from the alcohol by the abstraction of the elements of water, but the acids in these supposed salts cannot be detected by the usual reagents; the *chlorid* and *oxalate of ethyle* are not decomposed by salts of silver and lime. When the ethers are heated with a solution of potash, they reassume the elements of water and regenerate alcohol and the acid. In their formation and decomposition these compounds present a close resemblance to the amides; corresponding to the acid amides we have *acid ethers*, or vinic acids. The bibasic acids with one equivalent of alcohol yield coupled acids (see p. 176) which are monobasic. In these and similar reactions, "the substances in which hydrogen or one of the elements at the positive extremity of the electrical scale, predominates, are attacked by oxygen, chlorine and other elements which are placed at the negative extremity of the scale, or by compounds in which these negatively electric elements predominate." The acids, chlorine, bromine and some metallic chlorids are thus electro-negative, while the alcohols, hydro-carbons and ammonia are electro-positive. This division is of necessity only relatively true; thus benzoic acid by its oxygen is negative to alcohol, but is positive to chlorine and nitric acid which act upon its hydrogen.—(Précis, Vol. II, pp. 495, 496.)

In the amides and ethers the ammonia and alcohol are active by their hydrogen, which unites with the oxygen of the acid; if we represent the residue of ammonia $NH_3 - H_2$ by *Am* and that of alcohol $C_2H_6O_5H_2$ by *Al* replacing O; the neutral amide of oxalic acid will be $C_2H_2O_2$ *Am*$_2$ and oxamic acid $C_2H_2O_3$ *Am;* oxalic ether will be $C_2H_2O_2$ *Al*$_2$, and oxalovinic acid $C_2H_2O_3$ *Al.* The action of ammonia upon neutral ethers results in the regeneration of alcohol and the formation of amide. In this way Malaguti has succeeded in forming an immense number of amides. When ammonia is added to oxalic ether in a quantity insufficient to form oxamide, a beautiful crystalline, neutral compound results, which was first discovered by M. Dumas and by him named *oxamethane;* it is an ether-amide and its composition may be represented by C_2H_2 *Am Al.* Oxamethane is an example of a large class of similar compounds which are formed by the action of ammonia upon the bibasic ethers; M. Gerhardt adopts for them the generic name of *amethanes.* The sulphuric ether of wood-spirit, with ammonia, forms *sulphamephylane*, which is SH_2O_2 *Am Al*, the ether being SH_2O_2 *Al*$_2$.

The ethers of the organic acids are often formed by heating the acid with alcohol, but the action is slow and incomplete, and they are best obtained by distilling a mixture of the alcohol and acid with sulphuric acid. When the ether is not volatile it is easily prepared by passing hydrochloric acid gas through a hot solution of the acid in alcohol; in this way the ethers of the fatty acids are obtained. The ethers are generally artificial compounds, and produced by the reaction of the alcohol and acid; the salicylic ether of wood-spirit however, constitutes the principal part of the essential oil of wintergreen, *Gaultheria procumbens*, and similarity between the odors of many ethers and those of different fruits, renders it not improbable that the odor of the latter may be due to them. Benzoic ether has been observed as a product in the dry distillation of the resin of Tolu balsam.

The ethers of the hydracids contain, like the other ethers of monobasic acid, the elements of one equivalent of alcohol and one of acid *minus* one equivalent of water; but the acid does not contain either the oxygen or hydrogen to form the water eliminated, and hence, according to the view just given, they cannot be regarded as ethers. M. Gerhardt considers them as species, derived from the compound C_2H_6, to which he has given the name of *acetene.* Hydro-chloric ether is *chlorinized acetene* C_2H_5Cl; when heated with potassium it is decomposed and yields chlorid of potassium and a crystalline compound which is C_2H_5K. This is decomposed by water into potash and an oily liquid, which was described by Löwig as the radical ethyle, but is really acetene. The hyponitrous ether of Liebig is *nitric acetene* $C_2H_4NHO_2$. The corresponding compounds of wood-

spirit are the derivatives, a homologous body *formene* CH_4, which is marsh gas.*

The product of the action of sulphuric acid upon alcohol known by the name of ether, contains in an equivalent, = 2 volumes of vapor, the elements of two equivalents of alcohol minus one of water, $2(C_2H_6O)-H_2O=C_4H_{10}O$. It is found by the accouplement of two molecules of alcohol, and like other coupled bodies, by the influence of acids and chlorine, reassumes the elements of water and yields products which are derived from alcohol. It is evident that ether cannot exist in the ethers of acids as Liebig supposes. The gaseous ether of wood-spirit (methylic gas) is identical with alcohol ether in constitution.

Glycerides.—The researches of Scheele and Chevreul have shown that the vegetable and animal fats are decomposed by the action of potash, lime, and other energetic bases, furnishing a fatty acid and a sweet soluble substance, to which the name of glycerine is given. They were hence regarded as salts of glycerine, until it was shown that this body could not exist in them, when Berzelius proposed to consider them as compounds of the acids with the oxyd of a compound radical, *lipyle*, which formed glycerine by uniting with the elements of water. The inadequacy of such theories has been already seen; our author proposes to regard them as compounds, which like the ethers are derived from the elements of the acid and glycerine by the abstraction of the elements of water. The glycerids of the monobasic acids (the only ones as yet known) contain the elements of two equivalents of the acid and one of glycerine *minus* three of water; stearine is represented by $2C_{10}H_{18}O_2+C_3H_3O_3-3H_2O=C_{44}H_{78}O_4$. The glycerids are decomposed by alkalies with the assimilation of the elements of water; concentrated sulphuric acid acts in the same manner and forms a coupled acid with the glycerine; ammonia decomposes them and yields an amide of the acid: this has been observed in the case of margarine, which produces *margaramide*.

The principal glycerids known are those of the group of homologous acids mentioned on page 99; all of these acids, with the exception of the formic, acetic, and metacetonic, are known to have corresponding glycerids. The *phocenine* obtained by Chevreul from porpoise-oil, is the glyceride of valerianic acid, which the researches of Dumas and Munro have shown to be identical with the phocenic.

The glycerids have hitherto been known only as the products of the vegetable and animal organism, but MM. Pelouze and Gelis have lately observed that on heating a mixture of butyric acid and glycerine, a neutral oily substance separates, which appears

* See page 172.

to be identical with the *butyrine* of butter, and like it is decomposed by potash, with the formation of glycerine and a butyrate.

Among the other glycerides are oleine, that of castor oil, and some more which have been but partially studied. Oleine undergoes a singular change by the action of nitrous acid or protonitrate of mercury; when a few bubbles of nitrous acid gas are passed through it, it solidifies after a short time into a granular mass, which when saponified affords a white crystalline acid, identical in composition with the liquid oleic acid. Castor oil yields a similar result with nitrous acid, and the same effect is produced upon it by sulphurous acid gas. The glycerids are characterized by evolving the pungent oder of *acroleine* when decomposed by heat.

Alkaloids.—The organic alkaloids are a class of nitrogenized bodies which unite directly with acids. Ammonia may be taken as the representative of them. This substance combines with nitric acid NHO_3, and with the nitrate of copper $NCuO_3$, in both cases forming neutral salts. As the compounds of ammonia with acids present a close resemblance to the salts of potash, it was proposed to regard them as containing a compound metal NH_4, which replaces the hydrogen. The nitrate of ammonia $NHO_3.NH_3$, is upon this view $N(NH_4)O_3$, assimilated to nitrate of potash NKO_3. But this view is sustained but by few analogies. Since ammonia unites in the same manner with acids and their salts, the latter as the ammonia-nitrate of copper $NCuO_3.NH_3$, must be assumed to contain another compound metal NH_3Cu; and from the complete similarity between ammonia and the vegetable alkaloids, their salts according to this theory must each contain a compound metal which is composed of the elements of the alkaloid *plus* an equivalent of hydrogen. In view of the immense number of hypothetical compounds which this theory requires, and the imperfect analogy upon which it is founded, it is preferable to regard the alkaloids and ammonia as bodies which unite directly with acids and metallic salts. Strychnine, for example, combines with nitric acid to form the compound $C_{22}H_{24}N_2O_2, NHO_3$, and with nitrate of silver $C_{22}H_{24}N_2O_2, NAgO_3$.

These bodies may be divided into two classes; the first are those composed of carbon, hydrogen, and nitrogen. If the equivalent of these is low they are volatile liquids, but when this is more elevated they are often crystalline and not volatile without decomposition. Among them are anilene, quinoleine, nicotine, and conine, with naphthalidam and sinapoline. It is probable that none of these exist ready formed in plants, for although nicotine is obtained when tobacco is distilled with a solution of potash, late researches have shown that it is formed in the process, and the same is probably true of conine. These alkaloids,

at least the four first named, are very poisonous. The second class includes those which contain oxygen; these are all solid and crystallizable, and with but a few exceptions, obtained from plants, of which they constitute the active principles. Urea is the only alkaloid which is found in the animal organism, and the only natural one which we have been able to reproduce artificially. The action of ammonia upon oil of mustard and of sulphuretted and seleniuretted hydrogen and ammonia upon aldehyde, afford alkaloids in which sulphur and selenium replace oxygen. Alkarsine is one in which acesenic replaces nitrogen.

M. Hoffmann, in his late beautiful researches, has discovered several new alkaloids derived from anilene $C_6 H_7 N$, by a replacement of its hydrogen. *Chlorainline* and *bichlorainlene* correspond to anilene in which one or two equivalents of hydrogen have been replaced by chlorine, and two corresponding species are obtained which contain bromine. In nitranilene we have a beautiful instance of substitution by the residue of nitric acid. It is anilene in which $NHO_4 - O$ replaces H_2, and is represented by $C_6 (H_5 NHO_2) N$; although it contains the elements of a powerful acid its neutralizing power is the same as anilene itself.

The researches of M. Gerhardt have shown that the alkaloids, like ammonia, act by their hydrogen upon oxydized bodies to form compounds which correspond precisely to the amides. The oxalate of anilene when decomposed by heat loses two equivalents of water, and forms *oxanilide*, which, like oxamide, regenerates oxalic acid and the alkaloids by the influence of acids or alkalies. The anilide of formic acid has also been obtained, and *sulphanilic acid* which is monobasic, and corresponds to the oxamic. The *oxaluric acid* is a coupled acid in which urea sustains the same relation as ammonia in the oxamic; in its decomposition it assumes the elements of water and regenerates oxalic acid and urea.

The artificial alkaloids are formed by a great variety of processes. The action of fused hydrate of potash upon indigo or isatine results in the abstraction of its oxygen and a portion of carbon, which is oxydized at the expense of the water, and forms carbonate of potash, while anilene and hydrogen gas are evolved. The oxygenized alkaloids, quinine, cinchonine, and strychnine, by the same process afford quinoleine. The action of nascent hydrogen upon the nitric species of hydro-carbons has furnished many new alkaloids. When a solution of nitro-benzene $C_6 H_5 NO_2$ is mixed with dilute sulphuric acid and zinc, the liberated hydrogen combines with it and forms anilene with the liberation of two equivalents of water $C_6 H_5 NO_2 + 6H = C_6 H_7 N + 2H_2 O$. The same result is obtained by the action of sulphuretted hydrogen, the sulphur separating. It is from the decomposition of binitric benzene that nitraniline is obtained.

These bodies are often isomeric with amides of known substances, and M. Gerhardt regards them as all amidized species of some nonazotized substances, but differing from ordinary amides in not regenerating ammonia by the action of alkalies or acids. Mr. Fownes has observed that the amides of furfurol and benzoilol, which regenerate ammonia and the oils by the action of acids, may be boiled with a dilute solution of potash without evolving ammonia. On cooling, the alkaline solutions deposit crystals which have the same composition as the original amides; they are no longer decomposed by acids, but combine with them and form well characterized salts, being converted into alkaloids, (furfuroline and benzoline, or amarine of Laurent.) The alkaloids, melamine and ammeline, obtained by Liebig from the decomposition of sulphocyanate of ammonia, correspond to the amides of cyanuric acid, and by long boiling with a dilute acid, are decomposed into salts of ammonia and cyanuric acid. The direct action of ammonia upon organic substances sometimes produces alkaloids; amarine, the benzoline of Fownes, which is isomeric with hydrobenzamide, was obtained by Laurent by the action of ammonia upon a solution of the oil. Phenol combines directly with ammonia at ordinary temperatures, but if the compound is heated for some time in a closed tube, it gives up the elements of water and forms aniline, which corresponds to the amide of phenol. These compounds are designated by M. Gerhardt as *alkalamides*.

There are many other subjects in this portion of the work which it would be interesting to notice, as the characters of the carburets of hydrogen, their constitution and boiling points; but this sketch has already exceeded its proposed limits, and their consideration must be reserved for another time.

The third part of the first volume is devoted to the consideration of the effects of heat and other reagents upon organic substances, and the nature of the changes which they undergo. This is followed by a particular description of all organic bodies, arranged in the order of their families. The latter part of the second volume contains an exposition of the theory of homologues, with an ingenious application of the principles developed in the previous portions of the work, to a natural classification of organic substances with reference to their origin and derivation from each other, and which may form the subject of another notice.

In conclusion, we recommend to all interested in the progress of chemistry, the study of this work, which by its profound research, grand generalizations, and beautiful system, establishes the title of its talented author, to a high rank among the philosophers of the age.

ART. XV.—*On the relative Age and Position of the so-called Nummulite Limestone of Alabama;* by C. LYELL, F.R.S. and V.P.G.S.

IN a former paper, published in the Quarterly Journal of the Geological Society of London,* I stated that the limestone containing abundantly the Nummulites Mantelli, Morton, which occurs near Suggesville, Clarksville, and other places between the rivers Alabama and Tombeckbee in the state of Alabama, was a member of the eocene tertiary group, and that so far from constituting any part of the cretaceous formation as had formerly been imagined, it holds in reality a place high up in the eocene series of the South. In the same memoir I gave a section extending from Claiborne through Suggesville and Macon to the west of Clarksville, Alabama, in which the position of the so-called Nummulite limestone was explained. It was stated to be newer than all the beds of the well-known Claiborne bluff, and I mentioned that "the bones of the gigantic cetacean called Zeuglodon by Owen, were everywhere found in Clarke county, in a limestone below the level of the Nummulite rock, and above the beds which contain the greater number of perfectly preserved eocene shells, such as Cardita, Planicosta and others."†

At the time that my first communication was written, I had not finished my explorings in Alabama nor visited St. Stephen's bluff on the Tombeckbee river, where I afterwards obtained additional proofs of the order of superposition above indicated. Nor had I then compared the eocene strata at Vicksburg with those of Jackson in the state of Mississippi, which throw light on the same question of relative position. Before adverting to these last mentioned localities, I will first offer a few observations on the country between Claiborne and Clarksville, for I understand that doubts have been lately thrown on the correctness of the views which I have expressed relatively to the true age and place in the series to be assigned to the "rotten limestone of Alabama," and the associated rock in which the fossil first named Nummulites Mantelli, by Morton, abounds.‡

Before restating the grounds of my former opinion and corroborating it with fresh proofs, it may be well to say something of the nature and zoological relations of the discoid bodies from Alabama which have passed under the name of Nummulites and

* Vol. ii, p. 405, May, 1846.

† Quart. Journ. Geol. Soc., vol. ii, p. 409, May, 1846.

‡ Sir R. I. Murchison announced to the Geological Society of London, at their meeting, May 26th, 1847, that he had just received a letter from M. Agassiz, in which he stated that M. Desor had clearly shown that the rotten limestone of Alabama was not cretaceous, as Morton and Conrad had supposed, nor eocene, as Lyell had considered it, but was of the age of the *terrain nummulitique* of Biaritz.

which constitute the chief part in bulk, of considerable masses of limestone in certain districts. Having obtained many specimens both from Alabama and from Vicksburg in Mississippi, in which the structure of this fossil was beautifully preserved, I first showed them to Prof. E. Forbes, who at once pronounced them not to be Nummulites, but related to some living plants or zoophytes which Mr. Jukes had brought from Australia. Mr. Lonsdale, who examined them immediately afterwards, said, "They are certainly not Nummulites, but allied to some of the bodies usually termed *Orbitolites*, and are I believe *corals* in the usual acceptation of that word." Afterwards Mr. Forbes having compared the American fossil with the living species from Australia and satisfied himself of its near affinity, sent me the following note, dated June 14th, 1847. "On the so-called 'Nummulites Mantelli.' The American Nummulites Mantelli, judging from Mr. Lyell's specimen, is not a Nummulite nor is it a foraminiferous shell. It is a species of *Orbitolites* and consequently a zoophyte, (probably Ascidian.) The genus *Orbitolites* was established by Lamarck for the reception of a fossil of the Paris basin, the *Orbitolites complanata*, which may be regarded as the type. Other tertiary species and a Maestricht fossil, were associated by Lamarck in the same genus, in which he also placed the '*Orbitolites marginalis*' of the European seas. Respecting the true position of the last-named body, however, there is considerable doubt."

The *Orbitolites* complanata is very nearly allied to the American fossil. The *Orbitolites elliptica* of Michelin, from near Nice, and that author's *Orbitolites Pratti*, are also closely allied species.

In British strata, species of Orbitolites are recorded from the greensand of Milber down, from the chalk of Lewes, and from the coralline crag of Sutton. It is possible however that bodies belonging to distinct genera have been placed together in our lists.

Mr. Jukes has collected at Swan river, in Australia, numerous disciform bodies, apparently Ascidian zoophytes, which occur there in great numbers upon marine plants resembling Zostera, and when dead are found in great abundance in mud, procured by the dredge from various depths under seventeen fathoms. These disks are usually about half an inch in diameter and are composed of minute cells. They appear to me to belong to the same generic group with the tertiary Orbitolites, and such appears also to have been the opinion of Defrance, for we can scarcely doubt that these are the bodies alluded to by him (in the following passage) as living in the seas of New Holland: "Cette espece" (i. e. *Orbitolites complanata* of the Paris basin) "a les plus grands rapports avec celle que l'on trouve vivant dans les mers de la Nouvelle Hollande."* Marginopora of Quoy and Gaimard seems to be a similar body.

* Dict. des. Sc. Nat., p. 36, Art. Orbitolites.

As the subject stands at present, then, we have no right to infer from the presence of an Orbitolite however abundant, that the stratum in which it occurs belongs to one period more than another between the commencement of the cretaceous epoch and our own times.*

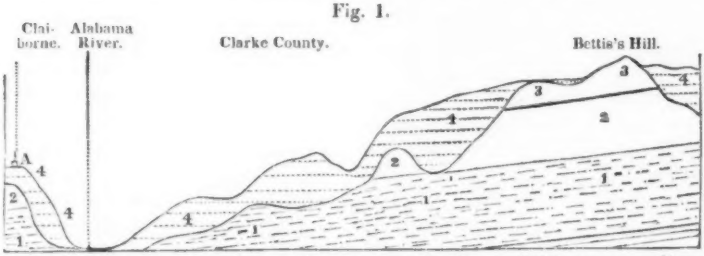
In my former paper, I endeavored to point out the cause of the obscurity in which the true age of the Orbitolite limestone of Alabama had been involved, it having been considered sometimes as an upper cretaceous group, and at others as intermediate between the cretaceous and the eocene formations. The accompanying section from Claiborne bluff to Bettis's Hill, near Macon in Alabama, may serve to explain the relations which I found to exist between the white limestone group of the south, comprising the successive formations 1, 2, 3, and the overlying group 4, which is perhaps of equal thickness but which from the absence of calcareous matter rarely yields organic remains, and those consisting only of silicified casts of shells and corals. This upper formation (4) is composed of variously colored red, pink and white sands, and of yellow ochre-colored sands, white quartzose gravel and sand with beds of chert and flint, blood-red and pink clays and clays of white kaolin or porcelain earth all horizontally stratified. I could find no fossils in those in Alabama, and only conjectured that they are of eocene date from the analogy of Georgia, where a deposit of the like aspect and nature and occupying a similar position contains eocene shells and corals. I formerly explained in 1841–42, the relative position of the upper clay and sands with flint of the burrstone formation of Georgia to the underlying white limestone and marl of the state of South Carolina, in a diagram published in the Journal of the Geol. Soc., vol. i, p. 438, where the newer group is represented as resting on the eocene limestone of Jacksonborough, near the Savannah river. It appeared in that case as in Alabama, that the older calcareous strata of limestone and marl, had undergone great denudation and had acquired a very uneven surface, having been shaped into hills and valleys, before the incumbent clays and sands were thrown down.

At the bluff on the Alabama River at Claiborne, where so rich a harvest of fossils has been obtained, especially in some of the beds of No. 2, we see at one spot called "The old landing," that nearly the whole precipice in its lower one hundred and sixty feet, exposes to view the calcareous beds 1 and 2, covered with about twenty feet of red clay and sand. Whereas at the distance of less than a mile from this spot, the upper formation No. 4, occupies more than one hundred feet of the face of the same cliff from its summit, while at the base the lower members of the cal-

* "The Plagiostoma dumosum of Morton, is decidedly a Spondylus."

careous series crop out from beneath the horizontal and incumbent beds of sand and clay. This twofold composition of the mass of strata in the bluff at Claiborne, is expressed at A, in the annexed wood-cut, (fig. 1,) and I verified a similar mode of juxtaposition

Fig. 1.



1. Eocene sand, marl, &c., with numerous fossils.—2. White or rotten limestone; Zeuglodon, nautilus, &c., eocene.—3. Orbitolite limestone, eocene.—4. Overlying sand, clay, &c., eocene.

of the two series of beds in several places in the interior of Clarke County, where the limestone often ends abruptly and is succeeded sometimes in the same ridge or hill by the newer beds, (No. 4.) the latter having evidently filled up the inequalities of a previously denuded deposit, after which the whole was again denuded.

I have suppressed several details and repetitions of the same phenomena in the country represented in the above diagram, (fig. 1,) and have been obliged to give a considerable inclination to the strata, because in the distance of twelve or more miles between Claiborne and Bettis's Hill, although the dip is not perceptible to the eye, the same beds are at the latter place more than twice as high above the Alabama river as at Claiborne. The mass No. 1, about one hundred feet thick at Claiborne, which constitutes the lowest visible member of the eocene series in this region, comprises marly beds with *Astrea sellæformis* seen at the base of the cliff at Claiborne, and an argillaceous stratum with impressions of leaves and sandy beds, with marine shells among which are found Cardita alta and Cardita planicosta, Cardita parva, Crassatella prætexta, Cytherea æquorea, Oliva Alabamensis, Pleurotoma (several species), Solarium canalicaletum, Crepidula lyrata, Endopachys alatum, Lonsdale, and two hundred other species. No. 2, about fifty feet thick, is the white or rotten limestone, which is sometimes soft and argillaceous, but in parts very compact and calcareous, and contains Flabellum cuneiforme, Lonsdale, Scutella Lyelli, Conrad, Lunulites, and several shells, some peculiar, others common to the formation below. Mr. Conrad has already described this section at Claiborne, and I hope soon to give a fuller notice of it with the observations which I made there in 1846. Of the limestone, No. 2, only the lower portion is seen here, for it

is cut off at the top of the bluff by the newer series of beds No. 4, but in many parts of Clarke County, as near Bettis's Hill and near Clarksville, the same No. 2 is found more largely developed. It is characterized among other organic remains by a large Nautilus allied to N. ziczac and by the gigantic zeuglodon of Owen. Near the juncture of the mass with the incumbent Orbitolite limestone, we find Spondylus dumosus, (Plagiostoma dumosum, Morton,) Pecten Poulsoni, Pecten perplanus, Ostrea cretacea, in abundance.

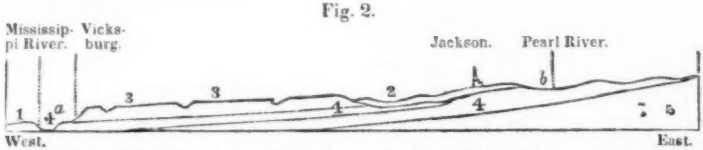
No. 3 is a pure limestone, sometimes hard and full of Orbitolites Mantelli. At Bettis's Hill the formation is about sixty feet thick, and the upper beds are composed of a cream-colored soft stone, which hardens on exposure to the air, is not divided by lines of stratification, and is for the most part made up of Orbitolites of various sizes, with occasionally a Lunulite and other small corals, with specimens of Pecten Poulsoni. The origin of this limestone like that of our white chalk, the softer varieties of which it much resembles, is I believe due to the decomposition of corals, and like our chalk downs, the surface of the country where it prevails is sometimes marked by the absence of wood, by which all the other deposits in this part of Alabama are continuously covered. The spots where few or no trees appear are called "bald prairies," but in some places, and at Bettis's Hill among others, the Orbitolite rock produces what is termed a "cedar knoll;" the red cedar, *Juniperus virginiana* having exclusive possession of the ground. I was much struck with the resemblance of such calcareous tracks, covered with the trees above mentioned, to certain chalk regions in the south of England, where the only wood which grows on the white rock consists of yew trees accompanied here and there by shrubs of juniper.

At St. Stephens, on the left bank of the Tombeckbee river, in Alabama, a similar limestone with Orbitolites forms a perpendicular bluff. The water of the river at the time of my visit was too high to enable me to collect fossils from the older beds at the base of the cliff, but I was afterwards furnished with them through the kindness of Prof. Brumby of Tuscaloosa. They are imbedded in a ferruginous ochreous-colored sand, and consist in part of shells common to Claiborne bluff, such as Terebra costata, Conrad, Cardita parva, Dentalium thalloides, Flabellum cuneiforme, Lonsdale, Scutella Lyelli, Con., and several more.

I shall now conclude by adverting briefly to the result of a comparison which I made of the fossils contained in the eocene strata of Vicksburg, on the left bank of the Mississippi river, the position of which is indicated at 4*a* in the wood-cut on the next page, with those of other eocene beds forty-five miles further inland or eastward at Jackson, in the same state. In the former of these at 4*a*, the Orbitolites Mantelli abounds, together with Pecten Poulsoni, Dentalium thalloides, Sigaretus arctatus, Con., Terebra

costata, Con., and a few others common to Claiborne; but the great bulk of the associate fossils do not agree specifically with those of Claiborne bluff. I found these distinct species at Vicksburg to be referable to the genera Voluta, Conus, Terebra, Fusus, Murex, Cassis, Pleurotoma, Oliva, Solarium, Natica, Turritella, Corbula, Panopæa, Crassatella, Lucina, Venus, Cardium, Arca, Pinna, Pecten, and Ostrea, with several corals, the whole having a decidedly tertiary and eocene aspect. The genus Pleurotoma, for example, which is represented by several species, is one of the forms most characteristic of tertiary as distinguished from secondary formations.

Fig. 2.



1. Mud of alluvial plain of Mississippi.—2. Superficial drift.—3. Freshwater loam with land shells.—4. Eocene strata.—5. Cretaceous strata.—Length of section fifty miles.

At Jackson, which, as before stated, is more than forty miles to the eastward, eocene beds, older than those of Vicksburg, crop out near to the area occupied by cretaceous deposits, as at *4b*, wood-cut, (No. 2.) Here on the Pearl river I found no specimens of Orbitolites Mantelli, although some are said to have been met with in the vicinity. But I observed that a larger proportion among the fossils, were specimens common to Claiborne bluff, than at Vicksburg. Among these may be mentioned Cardita planicostata, Cardita rotunda, Cytherea æquorea, Natica, like one which I obtained at Claiborne, Flabellum cuneiforme, Lonsdale, and Endopachys alatum, Lonsd., (Turbinolia Maclurii of Lea.) These I found in strata of yellow loam, sand, and marl, on the Pearl river and in the banks and bed of one of its tributaries. The other shells collected by me at the same place, several of them I believe identical with Claiborne species, belong to the genera Voluta, Oliva, Terebra, Rostellaria, Murex, Plurotoma, Umbrella, Natica, Turritella, Crepidula, Dentalium, Corbula, Mactra, Lucina, Cytherea, Cardium, Cardita, Pectunculus, Nucula, Pinna, Pecten, and Ostrea. With these are corals, teeth of fish, &c. I was shown the remains of a Zeuglodon procured from the neighborhood, at a place five miles south of Jackson, on the right bank of the Pearl river, but as I did not visit the locality I cannot point out the precise place in the eocene series which it occupies. Some of the accompanying corals, however, were the same specifically as those occurring with the shells above mentioned at Jackson, and one of my informants stated that this Zeuglodon bed was immediately under "the rotten limestone."

London, June 18, 1847.

ART. XVI.—*Notice of some recent Additions to our Knowledge of the Magnetism of the United States and its Vicinity;* by ELIAS LOOMIS, Professor of Mathematics and Natural Philosophy in the University of the City of New York.

IN the forty-third volume of this Journal I have given a discussion of all the observations of magnetic dip in the United States with which I was then acquainted; and in the forty-seventh volume I have given the comparison of these observations with Gauss's theory. Quite recently we have received a most important addition to our stock of observations, from Major Graham, Prof. Locke, and Capt. Lefroy, published in the Transactions of the American Philosophical Society and the Royal Society of London. In order to make the American Journal a complete depository of our knowledge upon this subject, it is proposed to present an abstract of these new observations accompanied by a few remarks.

The observations of Major Graham were made in the years 1840, '41, '43, '44, and '45. Those of 1840 were made with a dipping needle constructed by Troughton and Simms, having a vertical circle eight inches in diameter, graduated to fifteen minutes. The azimuth circle reads to single minutes by the aid of a vernier. The observations subsequent to 1840 were made with an instrument by Gambey, having a vertical circle ten inches in diameter, and graduated to ten minutes. In conducting the observations, the usual precautions were observed of reversing the poles of the needles, and reading with face alternately east and west. The following is a summary of Major Graham's observations.

TABLE I.

Station.	Latitude.	Longitude.	Dip.	Date.
Lake Pohenagamook,	47° 28′	69° 13′	77° 49′·2	1843
Beau Lac,	47 22	69 3	77 47	1843
Madawaska River,	47 22	68 19	77 47·5	1843
River St. John,	47 17	68 27	77 44·5	1843
Fish River,	47 15	68 35	77 43·1	1843
St. Francis River,	47 11	68 54	77 43·5	1843
Grand River,	47 11	67 57	77 38·4	1844
Little Black River,	47 7	69 5	77 40·5	1844
River St. John,	47 4	67 47	77 31·0	1843
Falls of St. John,	47 3	67 45	77 29·5	1843
Peconk Hill,	46 59	67 47	77 32·2	1841
Big Black River,	46 57	69 27	77 37·5	1843
Aroostook,	46 47	67 47	77 24·1	1841
Blue Hill,	46 38	67 47	77 18·1	1841
River St. John,	46 35	69 53	77 25·9	1843
Branch of St. John,	46 25	70 4	77 24·8	1844
Park's Hill,	46 7	67 47	77 1·6	1840
Source of St. Croix,	45 57	67 47	76 57·4	1840
Taschereau's,	45 49	70 24	76 50·4	1844
Moose River,	45 39	70 16	76 48·5	1844

TABLE I.—*Continued.*

Station.	Latitude.	Longitude.	Dip.	Date.
Kennebec,	45° 20′	69° 58′	76° 23′·7	1844
Canaan Corner,	45 0	71 31	76 23·5	1845
Lake Memphremagog,	45 0	72 13	76 8·4	1845
Rouse's Point,	45 0	73 22	76 40·7	1845
Bangor,	44 48	68 47	76 11·6	1841
Portsmouth,	43 5	70 44	74 51·0	1844
Cambridge,	42 22	71 8	74 17·8	1842
Boston,	42 21	71 4	74 9·4	1841
West Point,	41 24	74 1	73 20·1	1840
New York,	40 43	74 1	72 28·9	1844
Philadelphia,	39 57	75 11	72 1·8	1842
Baltimore,	39 17	76 37	71 39·7	1842
Washington,	38 53	77 1	71 13·1	1842
Sabine River,	32 1	94 0	61 36·8	1840
Natchitoches,	31 44	93 15	61 15·9	1840
Gaines's Ferry,	31 28	93 45	60 57	1840
Mouth of Sabine,	29 44	93 51	58 32·9	1840
Mouth of Mississippi,	28 59	89 21	58 42·2	1840

The observations of Prof. Locke were made with instruments manufactured by the late Mr. Robinson of London. The dipping compass was furnished with two needles, each of six inches in length. The intensity apparatus was of the model invented by Prof. Bache, the needles being vibrated in a glass vessel nearly exhausted of air. The observations of 1838, '39, and '40 having already been copied into this Journal, are not here repeated. The following is a summary of the observations of 1841, '42, '43, and '44.

TABLE II.

Station.	Latitude.	Longitude.	Dip.	Intensity.	Date.
Isle Royale,	48° 6′	88° 47′	78° 7′·6	1·889	1843
Magnet Inlet,	47 28	88 1	78 38·5	1·910	1843
U. S. Agency,	47 28	88 0	77 13·5	1·950	1843
Houghton's River,	47 28	88 1	77 20·7	1·842	1843
Eagle River,	47 27	88 23	77 54·5	1·861	1843
Ontonagon,	46 52	89 31	77 13·2	1·865	1843
La Pointe,	46 47	90 58	76 56·0	1·875	1843
Encampment, Lake Superior,	46 44	87 43	76 58·3	1·856	1843
Sault St. Marie,	46 31	84 32	77 30·2	1·861	1843
Mackinaw,	45 54	84 10	76 38·8	1·864	1843
Toronto,	43 33	79 20	75 13·0	1·836	1844
Lockport,	43 11	78 46	74 44·2	1·808	1844
Rochester,	43 8	77 51	74 38·8	1·806	1844
Utica,	43 7	75 13	74 48·8	1·809	1844
Buffalo,	42 53	78 55	74 36·5	1·825	1844
Albany,	42 39	73 45	74 41·6	1·792	1844
Detroit,	42 25	82 56	73 32·4	1·815	1843
Boston,	42 22	70 59	74 5·7	1·767	1842
Cambridge,	42 22	71 8	74 14·9	1·774	1842
Ann Arbor,	42 16	83 39	73 13·7	1·828	1843
Ashtabula,	41 52	80 52	73 25·0	1·855	1844
Poughkeepsie,	41 41	73 55	74 5·0	1·799	1844
Cleveland,	41 30	81 42	73 8·0	1·824	1843
Huron,	41 26	82 27	73 0·0	1·817	1843
New Haven,	41 18	72 57	73 29·8	1·774	1842
Warren,	41 16	80 55	72 55·9	1·805	1844
New York,	40 43	74 1	72 37·2	1·783	1842

TABLE II.—*Continued.*

Station.	Latitude.	Longitude.	Dip.	Intensity.	Date.
Newark,	40° 43′	74° 10′	72° 48′·5	1·784	1843
Wellsville,	40 38	80 44	72 35·3	1·794	1844
Pittsburgh,	40 32	80 2	72 43·5	1·803	1841
New Brunswick,	40 30	74 25	72 43·2	1·785	1844
Princeton,	40 22	74 39	72 39·5	1·784	1844
Trenton,	40 13	74 40	71 59·0	1·790	1841
Wheeling,	40 8	80 47	72 19·3	1·813	1844
Bristol,	40 6	74 47	72 25	1·768	1842
Philadelphia,	39 57	75 10	72 0·1	1·784	1842
Chambersburg,	39 55	77 40	71 57·1	1·788	1842
Mt. St. Mary's College,	39 41	77 18	71 46·3	1·790	1842
Cumberland,	39 39	78 44	71 36·0	1·789	1844
Baltimore,	39 17	76 37	71 36·8	1·781	1841
Cincinnati,	39 6	84 22	70 25·4	1·795	1842
Washington,	38 53	77 1	71 22·7	1·786	1844
Georgetown,	38 53	77 3	71 19·0	1·768	1844
Mount Vernon,	38 41	77 7	70 55·5	1·782	1844

The observations of Capt. Lefroy were made in the execution of a plan for a magnetic survey of a considerable portion of the North American continent at the expense of the British government. This survey was urged upon the British Association in the year 1837, by Lieut. Colonel Sabine; and in the year 1839 he formed a plan to execute the survey in person, but being called upon to superintend the publication of the observations made at the colonial observatories, the survey was subsequently entrusted to Lieut. (since Captain) Lefroy. Lieut. Lefroy was provided with an inclinometer of nine inches by Gambey; a Fox's inclinometer of seven inches diameter; a portable unifilar magnetometer; an azimuth compass; a portable declinometer; a portable bifilar magnetometer; and a portable induction inclinometer. He left Montreal in May, 1843, and ascending the Ottawa river, proceeded by the way of Lakes Huron and Superior to the Lake of the Woods; thence to York Factory on Hudson's Bay; and thence to Lake Athabasca, where he spent the winter. In the spring of 1844, he descended McKenzie's river to the Arctic circle, and returned to Toronto near the close of the same year. He thus passed directly over the region of greatest magnetic intensity in the northern hemisphere. The following table contains a summary of most of Capt. Lefroy's observations, and includes also a few observations by Messrs. Younghusband and Rae.

TABLE III.

Station.	Latitude.	Longitude.	Dip.	Intensity.	Date.
Fort Good Hope,	66° 16′ N.	128° 30′ W.	82° 56′·0	1·802	1844
Fort Norman,	64 31	124 44	82 34·3	1·801	1844
Fort Simpson,	61 51	121 25	81 52·3	1·829	1844
Fort Resolution,	61 10	113 45	82 44·5	1·848	1844
Athabasca,	58 43	111 18	81 37·0	1·838	1843
Fort Vermilion,	58 25	116 15	80 48·0	1·811	1844
Pointe Brulée,	58 7	111 25	81 30·6	1·852	1843
Pierre au Calumet,	57 24	111 35	81 16·8	1·938	1843

TABLE III.—*Continued.*

Station.	Latitude.	Longitude.	Dip.	Intensity.	Date.
York Factory,	57° 0′ N.	92° 26′ W.	83° 47′·2	1·855	1843
Clearwater River.	56 39	110 49	80 36·2	1·850	1843
Portage de la Loche,	56 34	109 44	80 36·4	1·835	1843
Shamatawa,	56 21	92 56	83 36·2	1·861	1843
River de la Loche,	56 15	109 23	80 19·7	1·826	1843
Buffalo Lake,	56 5	108 51	80 37·0	1·854	1843
Fort Dunvegan,	55 56	118 34	78 46·2	1·809	1844
Portage Sonnante,	55 54	107 47	80 11·2	1·858	1843
Snake Rapid,	55 46	106 30	80 38·7	1·874	1843
Pine Portage,	55 43	105 50	80 40·3	1·884	1843
Great Devil's Portage,	55 40	104 49	80 30·9	1·875	1843
Little Rock Portage,	55 34	104 33	80 16·5	1·995	1843
Lesser Slave Lake,	55 33	115 53	78 39·0	1·833	1844
White Earth Portage,	55 32	93 50	83 2·9	1·862	1843
Frog Portage,	55 28	103 30	80 59·3	1·857	1843
Isle a la Crosse,	55 27	107 54	80 9·8	1·851	1843
Hill River,	55 25	94 0	82 55·0	1·871	1843
Long Portage,	55 15	94 25	82 13·9	1·879	1843
Portage des Epinettes,	55 6	102 42	80 52·6	1·871	1843
Oxford House,	54 56	95 30	82 38·8	1·877	1843
Windy Lake,	54 37	96 2	81 57·0	1·870	1843
Beaver Lake,	54 32	102 10	80 34·2	1·869	1843
White Fall Portage,	54 24	96 26	81 47·9	1·869	1843
Hairy Lake,	54 21	97 11	81 20·9	1·859	1843
Saskatchawan River,	54 5	111 44	78 5·2	1·811	1844
Norway House,	53 59	98 7	81 10·0	1·873	1843
Cumberland House,	53 57	102 19	80 24·9	1·867	1843
Saskatchawan River,	53 50	110 30	78 33·5	1·829	1844
Near the Pas,	53 48	101 28	80 24·4	1·892	1844
Old Norway House,	53 42	98 1	80 45·4	1·874	1843
Fort Pitt,	53 34	109 19	78 41·0	1·870	1844
Fort Edmonton,	53 31	112 57	77 54·2	1·809	1844
Lake Winnipeg,	53 31	99 12	80 16·8	1·862	1843
Devil's Drum Island,	53 19	100 40	80 0·0	1·826	1844
Saskatchawan River,	53 16	104 48	79 11·2	1·842	1844
Cedar Lake,	53 12	100 30	80 7·1	1·871	1843
Cross Lake,	53 10	99 32	80 28·2	1·876	1843
Grand Rapid,	53 8	99 28	80 26·5	1·875	1843
Saskatchawan River,	53 7	108 30	78 28·1	1·881	1844
Carlton House,	52 51	106 13	78 30·7	1·815	1844
Lake Winnipeg,	52 29	97 13	80 5·4	1·866	1843
Saskatchawan River,	52 23	107 4	78 16·6	1·859	1844
Lake Winnipeg,	52 21	97 9	80 24·4	1·900	1844
Lake Winnipeg,	51 44	96 48	79 39·0	2·031	1844
Lake Winnipeg,	51 34	96 40	79 6·1	1·903	1844
Lake Winnipeg,	51 4	96 21	79 31·5	1·918	1844
Fort Alexander,	50 37	96 21	78 57·4	1·857	1843
Lake Winnipeg,	50 27	96 38	79 5·2	1·867	1843
Mouth of Red River,	50 19	96 45	78 32·6	1·864	1843
Slave Portage,	50 11	95 37	78 57·1	1·867	1843
Upper Fort Garry,	49 53	97 2	78 17·8	1·862	1843
Rat Portage,	49 46	94 39	78 7·5	1·858	1843
Lake of the Woods,	49 23	94 41	78 10·2	1·861	1843
Prairie Portage,	48 58	90 1	78 26·2	1·858	1843
Rainy River,	48 48	94 31	77 57·4	1·895	1843
Lake Superior,	48 46	87 40	78 24·0	2·099	1844
Portage du Chien,	48 39	89 34	78 26·8	1·865	1843
Pic Fort,	48 38	86 39	78 37·1	1·846	1844
Fort Francis,	48 37	93 29	77 34·2	1·853	1844
French Portage,	48 35	91 7	78 20·4	1·860	1843
Sturgeon Lake,	48 27	92 41	77 44·8	1·861	1843
Fort William,	48 24	89 23	78 6·8	1·866	1844

TABLE III.—*Continued.*

Station.	Latitude.	Longitude.	Dip.	Intensity.	Date.
Pointe Tonnere,	48° 19′ N.	89° 2′ W.	78° 23′·2	1·876	1843
Otter Island,	48 6	86 17	79 43·6	1·801	1843
Michipicoton,	47 56	85 5	78 6·4	1·855	1844
Gargantua,	47 37	85 11	77 56·1	2·016	1844
Pointe aux Crêpe,	46 58	84 58	77 11·5	1·877	1843
Quebec,	46 49	71 16	77 15·3	1·814	1842
Pointe aux Pins,	46 29	84 41	77 14·7	1·862	1844
Three Rivers,	46 19	72 36	77 10·7	1·826	1842
Little River,	46 18	78 43	77 28·5	1·838	1843
Lac du Grand Vase,	46 18	79 26	77 21·7	1·846	1843
Tessalon Point,	46 16	83 31	76 59·3	1·852	1843
Lake Nipissing,	46 13	79 59	77 9·5	1·836	1843
Fort la Cloche,	46 7	82 25	76 50·2	1·802	1844
Snake Island,	46 7	83 0	77 5·5	1·833	1843
Pointe Baptême,	46 6	77 26	77 26·6	1·822	1843
Sorel,	46 2	73 0	77 17·0	1·815	1842
Lake Huron,	46 0	81 50	77 5·6	1·840	1843
Ricolet Falls,	45 57	81 1	76 45·4	1·870	1843
Kingsey,	45 48	72 19	77 40·0	1·808	1842
Grand Calumet,	45 45	76 40	76 44·4	1·826	1843
Pointe aux Chênes,	45 37	74 55	76 55·4	1·805	1843
La Combes,	45 32	74 9	76 50·6	1·825	1843
Montreal,	45 30	73 36	77 8·6	1·788	1845
Point Aylmer,	45 29	75 48	76 41·0	1·825	1843
Isle d'Urval,	45 24	73 46	77 21·1	1·806	1843
Stanstead,	45 2	72 10	76 19·5	1·799	1842
Penetanguishene,	44 49	80 1	76 20·1	1·860	1844
Goderich,	43 45	81 52	75 4·8	1·828	1845
Toronto,	43 39	79 21	75 15·5	1·836	1843
Niagara,	43 5	79 9	74 46·8	1·822	1845
Port Sarnia,	42 58	82 34	74 15·7	1·825	1845
Buffalo,	42 52	78 54	74 37·0	1·814	1845
Albany,	42 39	73 45	74 44·6	1·797	1842
Detroit,	42 24	83 0	73 38·8	1·820	1845
Cambridge,	42 22	71 8	74 19·5	1·777	1842
Amherstburg,	42 6	83 13	73 29·9	1·822	1845
Providence,	41 49	71 25	74 0·0	1·781	1842
West Point,	41 24	74 1	73 30·4	1·807	1842
New Haven,	41 18	72 57	73 27·4	1·773	1842
New York,	40 49	74 3	72 39·5	1·769	1842
Princeton,	40 22	74 40	72 43·5	1·783	1842
Philadelphia,	39 58	75 10	71 59·0	1·793	1842
Baltimore,	39 17	76 37	71 41·4	1·782	1842
Washington,	38 53	77 1	71 13·8	1·785	1842

Remarks on the Preceding Observations.

The preceding observations of dip combined with those previously made, enable us to draw the lines of equal dip for the northern part of the United States in a very satisfactory manner. The observations of Major Graham supply what was before wanting in the northeastern section of the United States. Those of Prof. Locke supply the deficiency in the northwest quarter; while those of Lieut. Lefroy extend over a large portion of the British possessions on the north of us. Our knowledge of the dip of the magnetic needle is therefore tolerably complete for one-half of the United States; but with the exception of the

five observations of Major Graham, the southern half of this country is still an untrodden field. Cannot some volunteers be found to do for the south, what has already been done for the north?

The observations of the magnetic intensity, possess, if possible, a greater interest than those of the dip. The region of greatest intensity for the northern hemisphere has now been surveyed; and what is the result? The greatest intensity anywhere observed in the northern hemisphere is 2·099; the intensity in Peru, as observed by Humboldt, being called unity. This intensity in Peru was formerly supposed to be the least which would be found in any part of the globe; but an intensity has since been found as low as ·743; so that the greatest magnetic intensity now known upon any part of the globe, is not quite *three times* the least. It was formerly attempted to explain the phenomena of terrestrial magnetism by supposing an enormous magnet to be situated within the earth, having one pole in the continent of North America, and the other south of New Holland. But if the poles of such a magnet approached very near the surface of the earth, the force of its attraction should there be many thousand times greater than it is at the equator. If it is proposed to explain the observed phenomena by a permanent magnet situated within the earth, then we must conclude that its poles are so far below the surface that we are *very little nearer* them at one point of the earth's surface than at another; we must place the poles full three thousand miles below the earth's surface. Then to explain the high intensity observed in Siberia, we must introduce a second magnet whose axis makes a considerable angle with the former. But all this has been attempted in vain. Such hypotheses will serve to explain the observed phenomena only in a very rude and inadequate manner. We must wait patiently until the entire globe has been surveyed, and then we may expect to see the Newton who shall develop the grand law of terrestrial magnetism. Within a few years we have made rapid progress towards obtaining the requisite materials for this research. For the most interesting part of this continent, the survey may be pronounced nearly complete. If we call the intensity under the equator in South America unity, this intensity slowly increases as we travel northward, amounting to 1·4 among the West India Islands, while at New York it amounts to 1·8. Lines passing through all those places on the earth where the intensity is the same, are called lines of equal intensity, or *isodynamic* lines. The particular object of the expedition undertaken by Lieut. Lefroy, was to trace out the line of 1·8, and determine the position of the point of greatest intensity upon this continent. This object has been accomplished. The isodynamic line of 1·8 is a closed curve of an oval shape, extending somewhat below lat. 40° in the longitude of Cincinnati, and reaching off nearly to

Beering's straits, including the great northern lakes and a considerable part of Hudson's bay. The isodynamic line of 1·85 is a smaller oval included within the former, and passing nearly through Fort Mackinaw. The isodynamic line of 1·875 is an oval 446 geographical miles in length, and 170 in breadth. Its centre is in latitude 52° 19′ N., and longitude 92° W.; where the intensity is 1·878. These are the results which accord best with all the observations of Lieut. Lefroy and Prof. Locke. But it must not be understood that the observations agree perfectly among themselves. Many of the observations present unexplained anomalies, which, in our ignorance of their cause, we ascribe to *local attraction*. Thus while the great mass of observations assign to the magnetic focus above mentioned an intensity of 1·878, and indicate that from this point the intensity slowly diminishes in every direction, a few of the observations indicate an intensity considerably greater. In three instances, Lieut. Lefroy observed intensities greater than 2, viz., in lat. 48° 46′, lon. 87° 40′, intensity 2·099; lat. 51° 44′, lon. 96° 48′, intensity 2·031; and lat. 47° 37′, lon. 85° 11′, intensity 2·016. And in sixteen instances he observed intensities greater than 1·878. Prof. Locke also observed intensities greater than 1·878 in four instances, one of them rising as high as 1·950 in lat. 47° 28′, lon. 88° 1′. This point he inferred to be the point of maximum intensity for this continent; but Lefroy observed still higher intensities, and each of these cases was doubtless the effect of some local cause of limited extent. Within less than one mile's distance of the point where Prof. Locke observed the intensity 1·950, he found the intensity reduced to 1·842. The cause then, whatever it may be, of the high intensity on Porter's Island is extremely circumscribed in its influence. Prof. Locke has made some important observations to determine the laws of local attraction. At Patterson, N. J., on the summit of a trap rock one hundred and fifty feet high, he found the dip to be 75°; while at the bottom of the rock the dip was only 72° 17′; making a difference of 2° 43′ within a distance of a few hundred yards. Near Fort Lee, about nine miles north of New York, on the ridge of the palisades, the magnetic intensity at two stations only *forty feet* apart, was found to vary by nearly one-twentieth of its whole value. Prof. Locke infers that trap rocks become magnets by terrestrial induction, diminishing the magnetism of the earth at their bases, and increasing it at their summits.

Lieut. Col. Sabine, in his magnetic survey of Scotland, mentions an instance of local attraction even more remarkable than the preceding. In the northwestern part of Scotland, near Lake Scavig, on a rock intersected by trap veins, he observed a dip of 78° 10′. On the other side of the harbor, the dip was only 73°, being a difference of *more than five degrees*. These cases of local attraction deserve a particular examination.

ART. XVII.—*On the Trap Tuff, or Volcanic Grit of the Connecticut Valley, with the bearings of its history upon the age of the Trap Rock and Sandstone generally in that Valley;* by Rev. EDWARD HITCHCOCK, President of Amherst College.

(Read before the Association of American Geologists and Naturalists in Washington, May, 1844.)

IN my Reports on the Geology of Massachusetts, I have given a brief account of a rock under the name of *tufaceous conglomerate*, connected with the sandstone and trap of the Connecticut valley, which appears to me to deserve more attention. For if I mistake not, we have in its history, a clue that will conduct to the solution of some difficult questions concerning the relative age of the trap and sandstone, and the period of the elevation of the latter. I have, therefore, given this rock a reëxamination in that part of the valley within the state of Massachusetts, and propose to present the result in this paper.

I understand all tufas of igneous origin, to have resulted from fragments of scoriæ and pumice, with dust from the same, falling upon the dry land, or into the sea, when thrown up by volcanic eruption. Sometimes they carry along with them fragments of other rocks, and when they fall upon the bottom of the sea they mix with the sand and gravel there, and it may be that melted matter from the same eruption mixes with the tufaceous matter, so that rocks of every grade are produced, from perfect trap to stratified sandstones and conglomerates containing a portion of volcanic matter and altered by heat. Such an origin and such a composition correspond with the rocks which I am about to describe. I have observed in them the following varieties.

Lithological Characters.

1. *A hard reddish micaceous sandstone*, with more or less of volcanic matter, mostly dust or scoriæ. It is more or less metamorphic, often abounds in greenish spots, and passes insensibly into pure sandstone.

2. *Conglomerates.*—There are several varieties. The most common consists of rounded masses of trap, and occasional masses of red and grey sandstone, imbedded in a scoriaceous base. The nodules vary in size from that of a pea to masses two feet in diameter. The trap nodules are chiefly a fine grained greenstone. They are usually more or less rounded, but do not appear like the smooth pebbles in conglomerates of an entirely aqueous origin. They have evidently been worn mechanically, but their surfaces have been acted upon by heat, so as to have lost their smoothness.

Other varieties take into their composition, in addition to the trap nodules, distinctly rounded pebbles of older rocks, such as

granite, quartz rock, clay slate, &c. These rocks appear more or less crystalline in the structure of their cement, and contain, especially, foliated nodules of calcareous spar.

3. *Volcanic Breccia.*—This is composed of angular fragments of trap, of a highly ferruginous character, with a small proportion of cement of the same character. This rock abounds in the large ridges of intrusive trap in the vicinity.

4. *Amygdaloid*, with a somewhat compact base, and nodules of calcareous spar. The base has the aspect of indurated volcanic mud.

5. *Volcanic Slags.*—These differ but little from the amygdaloid, except in being more vesicular, and the cavities are empty. They cannot be distinguished from recent vesicular lava, except in not being so fresh.

6. *Concretionary Nodules.*—These are made up of concentric coats and are a dirty color and highly ferruginous. They are rarely more than three or four inches in diameter.

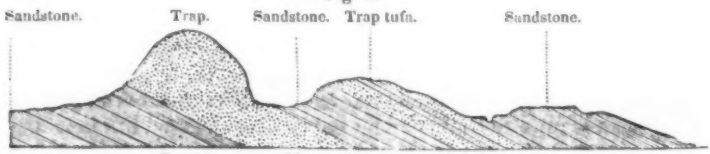
7. *Common Greenstone.*—This differs not at all from the greenstone that constitutes the great mass of the trap of this valley, except perhaps in being usually more compact.

8. *Porphyritic Trap.*—This takes distinct crystals of feldspar into its composition, and has a gray base more argillaceous than greenstone. The same rock occurs in connection with the principal ranges of trap.

Relative Position and Stratification of these Deposits.

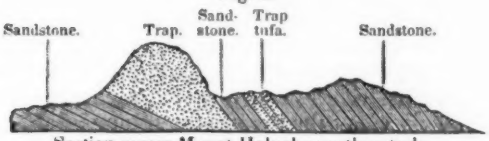
The usual dip of the strata of sandstone in the valley of Connecticut, is easterly, averaging about 15° or 20°; and the large ranges of trap appear to have been protruded to the surface between the strata. Consequently they lie upon the sandstone as seen on the west side of the range; while on the east side, the sandstone lies in an inclined position upon the trap, frequently with a higher inclination than the sandstone beneath. The east side of the trap, therefore, I call the *upper side*, and the west side, the *under side*. Now it is upon the upper side only that the trap tuff occurs. After receding a greater or less distance from the trap range, we find the tuff interstratified with the sandstone, as shown on the sections, figs. 1 and 2; and the tuff is also, for the most part, distinctly stratified conformably to the

Fig. 1.



Section across Mount Tom from west to east.

Fig. 2.



Section across Mount Holyoke southeasterly.

sandstone. I say for the most part; because when the mass is considerably thick, the west or the lower portion of it, is usually distinct greenstone, having no more stratification than trap in any other position. And so in the amygdaloidal and scoriaceous varieties, the stratification is indistinct, and indeed, in proportion as the igneous agency predominated, the rock loses its division into layers, and exhibits it where the aqueous agency predominated.

It ought also to be stated, that the amygdaloidal, scoriaceous, and porphyritic varieties of this rock occur of considerable thickness on the upper side of the principal ranges of trap, and to some extent they are stratified. The brecciated variety is, also, common, capping and underlying the columns, in various parts of the range. I have never, however, found the tufaceous conglomerates and sandstones as a part of the main range of trap, unless it be in West Springfield: where I was not able to find any sandstone between the conglomerate and the main range of trap.

Topography.

Nearly all the examples of this rock which I have discovered, occur upon what I call the back or southeasterly side of Mounts Holyoke and Tom. These form an almost continuous ridge, extending from Belchertown in Massachusetts, nearly to New Haven in Connecticut. Starting at Belchertown, we find the ridge running nearly west for several miles, then turning south to Connecticut river, and forming Mount Holyoke. Continuing across the river, it rises into the still higher ridge called Mount Tom; and thence in a lower ridge, into Connecticut. The top of this whole ridge is common trap, prismatic, amygdaloidal, and scoriaceous, resting upon thick bedded sandstone, which crops out upon its western and northern side; and on its other side, grey and red micaceous sandstone and shale shoot up upon its back. Now it is within this great curve of the principal trap range, and on its back side, that all the deposits of trap tuff, with which I am acquainted, occur. Three of these are shown on the map, Plate I, on the south side of Holyoke, in Granby and South Hadley. There may be others there: but the country being chiefly covered with thick woods, it is difficult to explore it. On the opposite side of Connecticut river, a still larger deposit occurs in Northampton,

on the back side of Mount Tom. In West Springfield, another narrow deposit is marked, as if imposed directly upon the principal range of trap; though it is doubtful whether there may not be sandstone interposed. Some very interesting boulders of one variety of this rock have been found in Amherst, torn off probably from the back side of the trap range running northerly through Sunderland, Deerfield, and Greenfield, where we still find a similar rock forming a part of the range. I have, also, seen many years ago, boulders of the tufaceous conglomerate, a few miles south of Hartford; but whether any large ledges exist there I know not.

Organic Remains.

The extreme paucity of organic remains in the new red sandstone of New England, and the highly igneous character of most varieties of the trap tufa, would lead us scarcely to expect any animal or vegetable relic in the rock under consideration. But in fact a single very distinct example does occur. It is a vegetable stem, from one to three inches in diameter, scarcely flattened. I found it in boulders of the porphyritic trap that has been described, scattered in abundance over the fields, in Amherst. I have not been able to trace it to its place in the mountains. But a similar rock abounds along the east side of the trap range running through Deerfield and Greenfield, and that too in just the direction from which the drift of Amherst has been derived. But in the ledges I have not found any vegetable stems. The largest boulder in which I have found these stems, is about two feet in diameter, and three of these stems run parallel to one another entirely through it, and do not diminish much in size, so that probably they were five times that length. The rock is a dark gray trap, not at all vesicular, yet occasionally containing prehnite and being porphyritic. But the stems are changed into what I have called a volcanic slag, being highly vesicular, resembling the toadstone of the geologists. I think this fact may be explained very reasonably; but it will be better understood when I have presented the theory of the formation of these peculiar rocks.

I ought to add, that I have been able to procure several of these unique specimens; but the best and largest has been divided between my own and the state collection of Massachusetts. Still farther I should state, that I have given a description of them with a poor drawing, in my Final Report on the Geology of Massachusetts; although I was there obliged to refer them to real trap rock, not having understood, as I think I now do, the relations of the trap tufa.

Mode and Period of the Production of the Trap Tufa.

Such are the facts in regard to this formation. I now come to the mode and period of its production.

Two positions in relation to this subject, I think will be easy to prove. The first is, that this rock must have been of contemporaneous production with the sandstone in which its beds are interstratified. The very fact of their being interstratified, shows that they could not have been subsequently injected. They are divided into layers, if not as thin, yet often as distinct, as the sandstone. Consequently, after the deposition of the sandstone on which they rest, they must in some similar manner have been deposited, before the layers of sandstone, now above them, were formed over them.

The second position is, that these rocks must have been the joint product of igneous and aqueous agency, The stratification and mechanical structure of some of the varieties clearly prove the agency of water, while the vesicular and concretionary structure of other varieties, and the entire resemblance of others still to unstratified trap, where the deposit is thick, as well as the volcanic character of the cement, even of the most decidedly mechanical layers, are equally conclusive proofs of the agency of heat. Indeed there is no part of the trap formation in this valley that presents so decidedly a volcanic aspect, as some of the weathered and disintegrated hummocks of this rock. It is impossible, then, to explain the production of this rock without calling in the joint action of fire and water. But how and when did this joint action take place? I adopt, almost without modification, the views advanced by Mr. Murchison, to account for the origin of similar rocks, called by him *volcanic grits*, and "bedded and contemporaneous trap," connected with the older fossiliferous rocks of Great Britain. He supposes them to have resulted from early and minor volcanic outbursts at the bottom of the ocean, at different intervals, previous to the period when the principal ranges of amorphous trap were protruded along the same lines. These preparatory eruptions would of course throw out abundance of scoriaceous matter, finely levigated, with some melted matter, which would spread over the bottom of the sea, and mix with the sand, gravel, and mud, there accumulated; so as to form the tufaceous conglomerates above described: while, if the quantity of liquid matter was large, a portion of it might cool slowly, and neither mix with the sand and gravel, nor come in contact with the water, except at the surface: and there the sudden refrigeration and commotion produced by the vapor and gases, would form scoriaceous and amygdaloidal rock. If in the bottom of the ocean this mixture of ashes, scoria, and lava, should envelope the remains of animals or plants, the heat might not be

sufficient to destroy all their organic structure, yet great enough to convert them into a scoriaceous mass; or if the organic matter had been driven off, to fill up the space with such matter rendered vesicular, (as in the particular case which I have described,) by the gas resulting from the decomposition of the organic compounds. Thus we might have organic remains in nearly melted rock, and thus might volcanic matter be made to take a stratified structure; but when quiet was again restored on the ocean's bed, new deposits of sandstone and shale would take place. After all this, the principal eruption of trappean matter might take place along nearly the same line, and the principal ridges of unstratified trap be protruded, and the sandstone and bedded trap, at least in the vicinity, be tilted up.

Now in respect to the sandstone and tufaceous rock of the valley of the Connecticut, we have the most decided evidence that those parts of these strata near the principal amorphous ridges of trap, have been elevated since their deposition. I have stated that the general dip of the sandstone in the valley is 15° or 20° easterly, both below and above (or west and east of) the trap ridges; and the fact that it is nearly the same below as above, shows conclusively that this general dip was not produced by the protrusion of the greenstone: for how could that elevate strata lying beneath it? It must, therefore, have been originally deposited with its present dip, or elevated by some other agency than the trap. But on the upper side of the trap ridges, we find numerous examples where the strata have been elevated very much more than the general dip; which greater slope, however, dies away as we recede from the trap. Take for an example, the section given on fig. 2; which crosses Mount Holyoke near its east end from Amherst southeasterly into Belchertown. Beneath the trap the dip is as usual; but on passing over the ridge, we find the strata dipping pretty uniformly as much as 50°, and running from N.E. to S.W. as if turned aside 45° from the usual course. The deposit of trap tufa, which is crossed by the section, shares in the increased dip. Now it is not possible that sandstone, most of it rather coarse, should have been deposited on a slope of 50°. It must have been tilted up after its deposition, and consequently after the deposition of the tufaceous rock. At the other beds of this rock, the dip is not much greater on the upper than on the lower side of the principal trap range. But along the south side of Holyoke generally, the dip is southeasterly, although not usually more than 20°; and I see not how this can be explained except by imputing it to the protrusion of the trap range in a direction at right angles to the usual strike of the strata of sandstone.

Near the northern extremity of the sandstone formation in this valley, at Turner's falls, we have another example, where the strata, composed of fine shales and sandstones, are raised for a

considerable distance from the ridge of trap, so as to dip 45°. But at this place is another fact still more conclusive to prove the elevation of the strata since their deposition. Those strata, dipping about 45°, are often covered with the most perfect footmarks in connection with raindrops, and not one of them have I ever seen in the least distorted, as if the animal had walked on a slope. The mud was so delicate as to retain the impressions of each phalanx of the foot most perfectly, and yet it has not yielded at all laterally. No one at all familiar with the tracks of living or extinct animals, can doubt that the surface must have been nearly level when these markings were made. The same is essentially the case at the Horse Race, three miles farther up the stream, and indeed at almost every locality of footmarks the slope of the strata appears to me too great not to have shown the slidings of the animal, if he walked upon it at the same dip which it now has. For I have some examples where the effect of walking on an inclined surface is manifest; and yet at that locality the dip rarely amounted to 10°. On the west side of Connecticut river in Northampton, where are numerous footprints of the huge Brontozoum giganteum, a majority of the rows of tracks cross the strata at right angles to the strike; so that if the strata had their present dip at that time—which is about 12°—either the animals must have walked so high up the bank that no tide or other rise of water could have covered them, as must have been done to bring over a layer of mud, or the strata must have had a less inclination than at present; since some of these rows are several rods long. The latter supposition seems to me to be the true one; and the general fact may here be stated, that, with one exception just discovered, (July, 1847,) it is only on the east or upper side of the trap ranges that the footmarks occur, doubtless because the water was too deep when the rock was soft. My theory is this: That the earlier outbursts of the trap, which perhaps formed the trap tufa, lifted the bottom of what was then the ocean, so as to form a low mud or sand beach, whither the birds resorted, and over which the water frequently flowed, loaded with silt. As successive masses of trap were protruded, successive deposits would come over it, on which other tracks might be formed; and it seems to me that in this way we might explain their occurrence upon successive layers, to a considerable thickness, without resorting, as Mr. Lyell does, to subsidences. And yet when volcanic agency was so common as we know it was during the volcanic period, vertical movements of the surface must have been a common occurrence.

But I have wandered somewhat from the subject in hand; and to return, it seems to me we have decisive proof that the protrusion of the principal ranges of trap constituting Holyoke and Tom, must have been the last of the changes that brought the

rocks of the valley into their present position; and that the tufaceous traps had previously been protruded and consolidated. It is possible that the principal ranges of trap may have been, at an earlier date than above supposed, partially elevated, and then ultimately have been thrust forward in a solid state, as we know to have been done in some modern examples. And, indeed, the fact that a portion of the turfaceous conglomerates contains really rounded masses of solid trap, shows at least that a good deal of that rock existed in order to furnish these materials. And it must have been more or less above the water in order that the currents should tear up and wear its fragments. This might in part have been done by igneous agency, as the masses were driven upwards through the fissure; yet they appear to me for the most part, to have been acted upon by water. And it is a curious fact that the ripple marks, in some places, show that the current was southerly, as it now is.

Tilting of the Sandstone Formation Generally.

We are conducted, then, as it seems to me, by these facts and reasonings, to a probable solution of the question concerning the relative age of the trap and sandstone of the Connecticut valley. It appears that all the thick bedded sandstone below the trap, constituting at least one-half, was deposited before the protrusion of any trap. Then succeeded some small outbursts, as precursors of the principal ones, and the bedded or contemporaneous trap was produced at intervals, while the upper beds of sandstone were being deposited; and last of all, the principal trap ranges emerged with considerable disturbance of the sandstone. But I have shown that the general dip of that rock, extending through the whole formation, was not the result of the protrusion of the trap. Was it then the result of original deposition, as some maintain, or of some other upheaving force? I incline to the last supposition for the following reasons:—

In the first place, if originally deposited with its present dip, the west side of the valley must have formed the shore of the ocean, and the materials have been brought in from the west side of the valley, and have gradually extended entirely across it, with a very uniform easterly dip. But most of the materials composing the sandstone and conglomerates, so far as it is possible to determine, appear to have been derived from the north.

In the second place, as already stated, we have some evidence in the ripple marks, that the current was from the north when the sandstone was deposited. I will mention one striking example. At the footmark locality in Northampton, the ripple marks on the fine sandstone are at right angles to the present course of Connecticut river; and as I was looking at them one

day, close at the water's edge, I saw that they appeared to be continued beneath the stream. But on close examination I found quite a deposit of mud above the rock, and on this mud the current had formed ripple marks very similar to those upon the stone. The rounded masses of trap, which enter into the composition of the tufaceous conglomerate, also, must have been swept southerly.

In the third place, the eastern side of the valley appears to have been elevated earlier than the west side, and to nearly the same height, as I have endeavored to show in my Final Report on the Geology of Massachusetts. If so, it must have presented currents moving from the west shore to the eastward, so as to carry materials for rocks across the entire valley, even if each shore had not been entirely above the waters. Yet we find in fact that the coarsest materials were deposited latest; that is, on the east side of the valley; but as the sides of the valley rose higher and higher, the easterly current, if it existed, must have been weaker and weaker; whereas, that elevation might have made a southerly current more violent, as we find must have been the case.

In the fourth place, a dip from 10° to 20° is too great to be the result of deposition, where the materials are very fine, as in the present case, and where they are spread with great evenness over large surfaces. Unless in peculiar circumstances, plastic materials cannot be retained on such a slope.

Finally, in the elevation and plication of the Hoosic or Green Mountain range, lying west of the valley, it may be by a lateral force, we have an adequate cause for the elevation of the sandstone. This will explain the uniformity of its dip through the whole valley, and its existence even on the eastern border of the valley. It appears to me, therefore, more in accordance with sound geological reasoning, to regard these sandstone strata as tilted up by some of those later movements, probably by lateral pressure, which folded up the Green, Hoosic, and Appalachian ranges.

ART. XVIII.—*On Terrestrial Magnetism;* by WILLIAM A. NORTON, Professor of Mathematics and Natural Philosophy in Delaware College.

(Concluded from p. 12.)

Declination of the Magnetic Needle.

THE first computation was of the declination for London, assuming the poles of greatest cold to be coincident with the magnetic poles. The result was a declination a number of degrees too small. After two or three trials I found that by placing hy-

pothetically the Asiatic pole in east longitude 160°, and lat. 65°, and the American pole in west longitude 72°, and latitude 67°, the declination came out very near the truth, and at the same time the mean annual temperature, as computed from Brewster's formula, by taking $n=\frac{3}{4}$, corresponded very closely with observation. It was supposed that, as the temperature of the Asiatic was some 4° (Fahrenheit) higher than that of the American pole, while in Brewster's formula they were regarded as equal, the former ought to be removed hypothetically to a greater distance, and the latter perhaps brought nearer. But the necessary changes of position, though lying in the direction thus suggested, are apparently much too great to be reasonably attributed to this cause. Upon making the calculations for other places, it was found necessary in each instance to place the cold poles hypothetically in positions more or less different from their true positions. The computed declinations, compared with the observed, together with the supposed longitudes and polar distances of the two cold poles, are given in the following table.

TABLE I.

Place.	Longitude.	Latitude.	Declination.		Diff.	American pole.		Asiatic pole.	
			Computed.	Observed.		Lon.	P. dist.	Lon.	P. dist.
London,	0° 6′ W.	51° 31′	24° 54′ W.	24° 0′ W.	+0° 54′	72° W.	23°	160° E.	25°
Paris,	2 21 E.	48 52	22 9 W.	22 4 W.	+0 5	65 W.	22	159 E.	25
Milan,	9 9 E.	45 28	19 3 W.	18 33 W.	+0 30	65 W.	23	155 E.	22
Göttingen,	9 56 E.	51 32	16 47 W.	18 48 W.	−2 1	70 W.	23	155 E.	22
Berlin,	13 24 E.	52 30	14 30 W.	17 5 W.	−2 35	70 W.	20	153½ E.	20
Spitzbergen,	11 40 E.	79 50	24 0 W.	25 12 W.	−1 12	85 W.	20	160 E.	25
Moscow,	37 37 E.	55 46	0 9 E.	0 8 E.	+0 1	70 W.	20	127 E.	12
Tobolsk,	68 16 E.	58 11	11 6 E.	10 29 E.	+0 37	80 W.	20	115 E.	12
Urga,	106 42 E.	47 55	2 10 E.	1 16 E.	+0 54	95 W.	20	106¾ E.	11
Pekin,	116 26 E.	39 54	1 1 W.	1 48 W.	−0 47	85 W.	20	101¾ E.	10
Stretensk,	117 40 E.	52 15	1 56 W.	2 52 W.	−0 56	85 W.	20	101½ E.	10
Jakutsk,	129 45 E.	62 1	6 30 W.	5 50 W.	+0 40	110 W.	20	110 E.	15
Tschernoljes	136 23 E.	61 31	2 52 W.	3 30 W.	−0 35	110 W.	20	115 E.	12
The Azores,	26 W.	36	24 11 W.	23 45 W.	+0 26	80 W.	25	134 E.	25
New York,	74 1 W.	40 43	3 20 W.	5 23 W.	−2 3	87 W.	15	86 E.	25
Washington,	77 1 W.	38 53	1 29 W.	1 41 W.	−0 12	85 W.	15	83 E.	25
Havana,	77 12 W.	23 9	5 20 E.	5 30 E.	−0 10	50 W.	10	83 E.	25
St. Louis,	90 15 W.	38 37	8 27 E.	8 44 E.	−0 17	70 W.	15	70 E.	25
Sitka,	135 25 W.	57 3	29 30 E.	28 19 E.	+1 11	85 W.	20	44 E.	25
	93 0 W.	50 0	6 35 E.	8 0 E.	−1 25	83 W.	16	67 E.	25
	93 0 W.	55 0	5 50 E.	7 0 E.	−1 5	86 W.	17	67 E.	25
	93 0 W.	60 0	5 0 E.	5 0 E.	0 0	90 W.	18	67 E.	25

The observed declinations were taken from Gauss's table of comparisons, Hansteen's table of declinations according to the latest observations, Loomis's table of comparisons of numerous determinations of declination for the United States by Gauss's formula with observation, published in the No. of this Journal issued in October, 1844, and in the case of the last three places and for the Azores, from Barlow's "Chart of Magnetic Curves of Equal Variation." The observation for Havana was made in 1816. None of the other observations date more than twenty

years back. The observed declinations for the United States were reduced by Professor Loomis to the epoch of 1837.

The following table contains the mean annual temperatures of the different places in Table I, as computed from Brewster's formula, with the values of the distances δ and δ' used in the calculations of the declinations. The formula is

$$T=(t-\tau)\,(\sin^n\delta\,\sin^n\delta')+\tau$$

and with the assumed values of the constants,

$$T=\left(28^\circ-(-19^\circ)\right)(\sin^{\frac{3}{4}}\delta\sin^{\frac{3}{4}}\delta')-19^\circ=47^\circ(\sin^{\frac{3}{4}}\delta\sin^{\frac{3}{4}}\delta')-19^\circ \quad . \quad (8.)$$

TABLE II.

Place.	M. Annual Temp. computed	observed	Diff.	Place.	M. Annual Temp. computed	observed	Diff.
London,	10°·5	10°·4	+0°·1	Jakutsk,	−7°·0	−9°·0	+2°·0
Paris,	10 ·7	11 ·0	−0 ·3	Tschernoljes,	−5 ·0	−7	+2 ·0
Milan,	13 ·5	13 ·6	−0 ·1	The Azores,	15 ·6	16	−0 ·4
Göttingen,	9 ·7	9 ·8	−0 ·1	New York,	10 ·6	10 ·7	−0 ·1
Berlin,	9 ·7	8 ·8	+0 ·9	Washington,	11 ·9	12 ·7	−0 ·8
Spitzbergen,	−5 ·3	−4	−1 ·3	Havana,	22 ·5	25 ·0	−2 ·5
Moscow,	5 ·0	4 ·4	+0 ·6	St. Louis,	12 ·6	13 ·0	−0 ·4
Tobolsk,	1 ·0	−1	+2 ·0	Lon. 93° W., Lat. 50°	3 ·3	2 ·5	+0 ·8
Urga,	6 ·9	6	+0 ·9	Lon. 93° W., Lat. 55°	−1 ·5	−2 ·5	+1 ·0
Pekin,	13 ·3	13	+0 ·3	Lon. 93° W., Lat. 60°	−6 ·6	−8 ·0	+1 ·4
Stretensk,	4 ·0	3	+1 ·0	Sitka,	2 ·7	3 ·0	−0 ·3

The observed mean annual temperatures were generally taken from Mahlmann's table, as published in the French edition of Kaemtz's Complete Course of Meteorology. The temperatures of the following places were obtained by estimation from Kaemtz's Chart of Isothermal lines; viz., Spitzbergen, Tobolsk, Urga, Pekin, Stretensk, Tschernoljes, the Azores, Sitka, and long. 93° W., lats. 50°, 55°, and 60°. The mean temperatures for Berlin, Paris, London, and Milan, are from observations continued through twenty-five, thirty-three, forty, and seventy years, respectively. For the other places the observations in no instance extend farther back than twenty years. The temperatures for Göttingen, Paris, Milan, Berlin, Moscow, and Jakutsk were reduced to the level of the sea by allowing 1° (centigrade) for from 173 metres to 190 metres of altitude, agreeably to Kaemtz's data. This is a larger allowance than it has been customary to make. According to Professor Forry no reduction is necessary for St. Louis.

In the calculation of Table II, t was taken in Brewster's formula very nearly equal to the mean temperature on the equator, and τ at about the temperature of the American pole of greatest cold. But it appears by the formula that t is the temperature which obtains at the point on the earth's surface where δ and δ' are both 90°. This point appears to be situated in Africa a few degrees north of the equator. Now Kaemtz gives for the temperature of the interior of Africa in the vicinity of the equator, and at an elevation of 300 metres, 29°·2. Reducing this to the

level of the sea we have 31° nearly. The value to be assigned to r would seem to be the mean of the temperatures of the two cold poles. According to Berghaus, these are, $-19°{\cdot}7$ and $-17°{\cdot}2$; the mean of which is $-18{\cdot}4$. The most probable values of t and r are then 31°, and $-18°$. The following table was calculated with these values, taking $n=\frac{8}{9}$; or by the formula

$$T=49°(\sin^{\frac{8}{9}}\delta \sin^{\frac{8}{9}}\delta') - 18°. \quad . \quad . \quad . \quad . \quad (9.)$$

It will be seen that the difference between the computed and observed temperatures in no case exceeds 1°, and is generally much less. Thus the same values of δ and δ' give by this formula the temperature of a place, and by formula (6), derived from this by differentiation, the declination of the magnetic needle.

Table III.

Place.	M. Annual Temp computed	observed	Diff.	Place.	M. Annual Temp computed	observed	Diff.
Berlin,	9°·3	8°·8	+0°·5	Havana,	24°·4	25°·0	−0°·6
Moscow,	4 ·1	4 ·4	−0 ·3	Washington,	11 ·8	12 ·7	−0 ·9
Stretensk,	3 ·5	3 ·0	+0 ·5	St. Louis,	12 ·6	13 ·0	−0 ·4
Tschernoljes	−6 ·4	−7	+0 ·6	Lon. 93° W., Lat. 50°	2 ·5	2 ·5	0 ·0
Urga,	6 ·2	6	+0 ·2	Lon. 93° W., Lat. 55°	−2 ·5	−2 ·5	−0 ·3
The Azores,	15 ·6	16	−0 ·4	Lon. 93° W., Lat. 60°	−8 ·0	−8 ·0	0 ·0

On examining Table I, it will be perceived that, leaving out of view the cases of Havana, Jakutsk, and Tschernoljes, the polar distance of the fictitious American pole varies between 23° and 15°, and its longitude between 65° and 95°. In Western Europe its longitude is from 65° to 72°; in Asia from 80° to 95°; in the eastern and northern parts of North America from 85° to 90°, and in the western part from 70° to 85°. The smaller polar distances obtain only on this continent. As to the Asiatic pole; on the meridian of Paris, over the Atlantic Ocean, and throughout this continent, it is to be taken 160° east of the meridian of the place, and at the distance of 25° from the geographical pole. In passing over Europe and Asia, the Asiatic pole moves westwardly, and at the same time approaches the geographical pole. At from 100° to 120° east longitude, it falls to the west of the meridian of the place, and its polar distance becomes from 10° to 15°. As we approach either magnetic pole, the hypothetical pole of maximum cold approaches this pole and the true position of the cold pole. A change either in longitude or latitude alters more or less the ideal positions of the cold poles. The changes of longitude and latitude of the Asiatic pole are about twice as great as those of the longitude and latitude of the American pole.

It appears from Tables II and III, that in using Brewster's formula for the calculation of the mean temperature of a place, each place may be regarded as having its particular cold poles. The results given in Table I, show that if we regard these poles

as stationary for an indefinitely small change in the position of the place, and determine the direction of the isothermal or isogeothermal line on this supposition, the needle makes a right angle with this direction. In point of fact however, these poles change their situation with every change in the position of the place; and hence, formula (6) will not give the true direction of the isothermal line. But the amount of the error will be quite different in different places. In high latitudes the displacement of the ideal cold poles is slight, and less in proportion as the place is nearer to either of these poles; and accordingly formula (6) gives very nearly the true direction of the isothermal line. From the meridian of Paris westward, across the Atlantic Ocean, and throughout the United States, while the change of longitude of the Asiatic pole is equal to that of the place, the change in its distance from the place from this cause is slight; since, as it has been seen, this pole is almost directly opposite to the place on the other side of the geographical pole. The motion of the American pole is much less, and tends to diminish the variation of the computed temperature produced by the motion of the other; since, while δ is increased by the one, δ' is diminished by the other, and thus the variation of $\sin^n\delta \sin^n\delta'$ in equa. (4), is less than would arise from the change of either δ or δ' alone. Throughout the portion of the earth's surface just designated, therefore, formula (6) gives nearly the true direction of the isothermal line. In passing eastwardly from the meridian of Paris, over Europe and Asia, the displacement of the Asiatic pole is more rapid, while that of the American pole is about the same. The two tend to counteract each other, but it would seem that the effect of the former must preponderate, and therefore that the true direction of the isothermal line may materially differ from that given by formula (6). The indications are, however, that the error lies in one direction over Europe and Asia, and in the other direction across the Pacific Ocean, and thus, that the isothermal line as traced by means of formula (6) would no where differ very widely from the truth.

On referring to a chart of isothermal lines, constructed from observations, (see Kaemtz's Complete Course of Meteorology, French edition, Plate VI,) it will be seen that generally the course of these lines is in fact similar to that of the lines traced by formula (6.) Thus, in crossing the continent of North America, from the western to the eastern coast, they tend south of east; and in crossing the Atlantic Ocean, from America to Europe, north of east. From Western Europe to the eastern coast of Asia, their direction is south of east. The points of inflexion, or of change of direction from one side to the other of the east and west line, of the two systems of lines, are however generally separated by a moderate interval. The comparison is here confined to the Temperate and Frigid Zones.

We may lay down the following great truths as apparently established by this discussion.

1. Lines traced upon the earth's surface such that the magnetic needle is every where perpendicular to their direction, have a very intimate relation to the isogeothermal lines, and a general correspondence of direction with them, indicative of a close physical connection between the distribution of the earth's heat and that of its magnetism.

2. If we assume that the intensity of the magnetism of each particle is every where proportional to its temperature, and that its magnetic force is of the character of a tangential force, (as it has been defined,) the formula which makes known the temperture furnishes by differentiation another which makes known the first set of lines above mentioned; and which differs from the formula for the isogeothermal lines only in this, that in the one, the displacement of the cold poles answering to an indefinitely small displacement of the situation of the place is taken into account, in the other neglected.

In what precedes, I have assumed, on the authority of Sir David Brewster, that the isothermal and isogeothermal lines are parallel to each other. If a more extended and minute investigation should reveal differences in the direction of these two classes of lines, it may be found that the lines of equal molecular magnetic intensity to which the needle is every where perpendicular, correspond more nearly in their direction with the true isogeothermal lines than with the isothermal lines, to which the isogeothermal lines have been assumed to be parallel.

The small differences which appear to exist between the isogeothermal lines and the lines to which the needle is perpendicular, (whether strictly lines of equal molecular magnetic intensity or not,) must be left for future consideration. I will only remark here, that the differences may prove not to be incompatible with the supposition made at the outset, that the terrestrial molecular magnetic intensity is strictly proportional to the temperature, as they may be attributable to a want of parallelism in the isogeothermal lines lying within the circle of sensible action upon the needle, geological differences in the earth's crust, &c.; and that, if they are incompatible with this supposition, they are not necessarily opposed to the undulatory theory of magnetism, since the supposed difference between the waves of heat and magnetism affords reasonable ground for the supposition, that there may be more or less of difference in the detail of the distribution of these two principles over the earth. It is to be observed, moreover, that, as it appears from the foregoing discussion that the differences between the two classes of lines follow a certain law, the molecular magnetic intensity is not only approximately proportional to the temperature, but must be rigorously connected with it by some law.

Horizontal Intensity.

The formula which has been investigated, for the horizontal component of the directive force, or the horizontal magnetic intensity of a place, is

$$\text{Hor. intensity} = C' T \quad . \quad . \quad . \quad (10.)$$

in which C' is an unknown constant, and T the mean annual temperature of a place; understanding by the mean annual temperature, the mean intensity of the heat of the earth at the place. Temperatures are experimentally obtained by means of thermometers, which give the height of the mercury above an arbitrary zero, and by an arbitrary scale. It is not to be supposed, therefore, that any of those in use furnish the proportional absolute amounts of heat. The only resource, then, is to add arbitrarily different numbers to the thermometric values of T until one be found, if possible, which will give values of the horizontal intensity that accord with observation. The following table gives the results obtained for a number of places, by adding 15° (centigrade) to T° (centigrade.) The formula was

$$\text{Hor. intensity} = H\frac{t+15^\circ}{T+15^\circ} \quad . \quad . \quad . \quad (11.)$$

in which H is the observed horizontal intensity for some particular place, T the temperature at this place, and t the temperature at the place for which the horizontal intensity is required. For the western continent H = horizontal intensity at New York = ·5291; for Europe, H = horizontal intensity at Paris = ·518. The temperatures, as in all other investigations in the present article, were taken from Mahlmann's table, or from Kaemtz, pp. 192, 193, and reduced when necessary to the level of the sea. The "observed" horizontal intensities were deduced from the observed total intensities and inclinations; these being derived from the same authorities as the declinations, with the addition of Sabine's Report on the magnetic intensity of the earth. To avoid repetition, I will here remark that the observations employed in the subsequent parts of this article were derived from the same sources.

TABLE IV.

Place.	Hor. Intensity. computed	observed	Diff.	Place.	Hor. Intensity. computed	observed	Diff.
New York,		·5291		Paris,		·518	
Montreal,	·443	·409	+·034	Moscow,	·382	·504	—·122
Dorchester,	·500	·481	+·019	Christiania,	·410	·437	—·027
Albany,	·500	·482	+.018	Königsberg,	·422	·479	—·057
Washington,	·571	·576	—·005	Berlin,	·474	·509	—·035
Cincinnati,	·575	·576	—·001	Edinburgh,	·478	·446	+·032
St. Louis,	·591	·616	—·025	Göttingen,	·494	·510	—·016
Chapel Hill,	·640	·645	—·005	London,	·506	·485	+.021
St. Augustine,	·770	·753	+·017	Milan,	·568	·571	—·003
Key West,	·820	·821	—·001	Marseilles,	·584	·543	+·041
Equator, eastern coast of S. America,	·882	·936	—·054	Naples,	·632	·657	—·025
				Lat. 25°, W. coast of Africa,	·754	·814	—·060
				Equator, do.	·854	·920	—·066
				do. do.	·921	·920	+·001

The second result for the equator, at the end of the table, was calculated from ·814, the observed horizontal intensity at latitude 25°, W. coast of Africa.

The following observed elements were obtained by estimation from the tables and charts of Sabine, Gauss, and Loomis: Chapel Hill, intensity = 1·77, dip = 68° 37′; St. Augustine, intensity = 1·66, dip = 63°; Key West, intensity = 1·55, dip = 58°; equator, E. coast of S. America, intensity = 1·06, dip = 28°; latitude 25°, W. coast of Africa, intensity = 1·3, dip = 51° 15′; equator, W. coast of Africa, intensity = ·920, dip = 0°.

It will be observed that the differences for Europe are greater than for America. The following table was calculated from the formula

$$\text{Hor. intensity} = H\frac{l+20^\circ}{T+20^\circ} \quad . \quad . \quad . \quad (12.)$$

TABLE V.

Place.	Hor. Intensity. computed.	observed.	Diff.	Place.	Hor. Intensity. computed.	observed	Diff.
Moscow,	·408	·504	—·094	London,	·508	·485	+ 023
Christiania,	·424	·437	—·013	Milan,	·561	·571	—·010
Königsberg,	·438	·479	—·041	Marseilles,	·573	·543	+·030
Berlin,	·481	·509	—·028	Naples,	·614	.657	—·043
Edinburgh,	·486	·446	+·040	Lat. 25°, W. coast of Africa,	·716	·814	—·098
Göttingen,	·500	·510	—·010	Equator, do.	·800	·920	—·120

The differences here are generally less than in the previous table. The same formula would however give results wider from the truth than the first one, for the western continent.

More accurate results might be obtained by making the calculations from the observed horizontal intensities of a greater number of places.

Theoretical investigations have conducted to the law that the change of temperature of the earth is proportional to that of the square of the cosine of the latitude, and observations are said to lead to the same conclusion. Assuming this law to be true, the temperature must every where be proportional to the square of the cosine of the latitude, plus or minus some number. That is, $T = A\cos.^2 \text{lat.} \pm C$. This gives the formula

$$\text{Hor. intensity} = H\frac{\cos^2 l \pm C}{\cos^2 L \pm C} = H\frac{1+\cos 2l \pm C}{1+\cos 2L \pm C} \quad . \quad . \quad (13.)$$

l and L denoting two different latitudes, and H the horizontal intensity at L. The results given in the following table are calculated from this formula, taking $C = 0$, and H = horizontal intensity at New York = ·5291.

TABLE VI.

Place.	Hor. Intensity. computed.	observed.	Diff.	Place.	Hor. Intensity. computed.	observed.	Diff.
Montreal,	·453	·409	+·044	Prairie du Chien,	·492	·505	−·013
Dorchester,	·503	·481	+·022	Dubuque,	·501	·516	−·015
Albany,	·498	·482	+·016	Louisville,	·561	·598	−·037
Springfield,	·507	·499	+·008	St. Louis,	·562	·616	−·054
Providence,	·511	·501	+·010	Lat. 35°, E. coast			
West Point,	·518	·521	−·003	of U. States,	·618	·665	−·047
New Haven,	·520	·507	+·013	Lat. 30°, do.	·691	·753	−·062
Princeton,	·535	·540	−·005	Lat. 25°, do.	·756	·821	−·065
Philadelphia,	·541	·549	−·008	Lat. 20°, do.	·813	·872	−·059
Washington,	·560	·576	−·016	Lat. 15°, do.	·859	·892	−·033
Hudson, Ohio,	·521	·532	−·011	Lat. 10°, do.	·893	·919	−·026
Cincinnati,	·555	·576	−·021	Lat. 5°, do.	·914	·917	−·003
				Equator, do.	·921	·936	−·015

It will be observed that the differences are greatest between the latitudes 15° and 35°. But the observed elements are less accurately known between these limits, being obtained by estimation. It would appear, however, that the supposition that $C=0$ in formula (13) is incorrect. It will be seen that the determinations for latitudes south of New York are almost all in deficiency, while those for places north of New York are in excess. More accurate results might accordingly be obtained by subtracting some number from $1+\cos 2l$ and $1+\cos 2L$. Table VII, was calculated in this manner, or from the formula

$$\text{Hor. intensity} = H\,\frac{1+\cos 2l - C}{1+\cos 2L - C} \quad . \quad . \quad . \quad (14.)$$

Different values were given to C for every different place. These values were empirically obtained from the observed temperatures in the following manner. Kaemtz in his Course of Meteorology, furnishes the following table of mean temperatures.

Temperature.	Latitudes. East Coast of America.	West Coast of Europe.
25°	24° 21′	18° 49′
20	32 20	31 27
15	38 24	41 33
10	41 30	52 3
5	44 51	60 7
0	51 57	66 48

Taking the data of the second column of this table, we find that the difference between the temperature at the equator and the temperature at a certain latitude varies as $1-\cos 2\text{lat.}-C$: so that at two different latitudes, l and L, the differences are as $1-\cos 2l-C : 1-\cos 2L-C$. The value of C changes more or less if we change either of the latitudes l or L. If we take $L=24° 21′$, and give successively to l the values 32° 20′, 38° 24′, 41° 30′, 44° 51′, 51° 57′, we find for C the values ·211, ·222, ·242, ·220, ·240. If we take $L=38° 24′$ and $l=41° 30′$, C=

·500. Now by taking L = latitude of New York, and l = latitude of the place for which the horizontal intensity is to be computed, and making use of the observed temperatures, the respective values of C determined as above, are those which have been empirically substituted in equation (14), and used in calculating the following table.

TABLE VII.

Place.	Hor. intensity.		Diff.	Values of C.
	Computed.	Observed.		
Montreal, . . .	·440	·409	+·031	
Washington, . . .	·573	·576	−·003	·380
Chapel Hill, Lat. 36°, .	·635	·645	−·010	·330
St. Augustine, Lat. 30°, .	·759	·750	+·009	·323
Key West, Lat. 24½°, .	·816	·826	−·010	·211

By taking the data furnished by the third column of the small table of temperatures just given, I find that on the western coast of Europe and Africa, the difference between the temperature at the equator and the temperature at a given latitude, varies as $1-\cos n$lat., n having various values for different latitudes, from 2 to 1·5. This makes the temperature proportional to $1+\cos n$lat. $+C$, C being some constant number, either positive or negative. For, supposing this to be the law of variation of the temperature, and denoting the temperatures at the equator and a given latitude (l) by T and T′, we have $T : T' :: 2+C : 1+\cos nl+C$. Whence $T : T-T' :: 2+C : 1-\cos nl$, and $T-T' = \frac{T}{2+C}(1-\cos nl)$. For any other latitude (L) we have in like manner $T-T'' = \frac{T}{2+C}(1-\cos n\mathrm{L})$. These equations give $T-T' : T-T'' :: 1-\cos nl : 1-\cos n\mathrm{L}$. We have therefore for the calculation of the horizontal intensity on the coast of Europe, the following formulæ.

$$\text{Hor. intensity} = \mathrm{H}\frac{1+\cos nl+C}{1+\cos n\mathrm{L}+C};$$

Or, assuming $C=0$,

$$\text{Hor. intensity} = \mathrm{H}\frac{1+\cos nl}{1+\cos n\mathrm{L}} \quad . \quad . \quad . \quad . \quad (15.)$$

Table VIII. contains the results of numerous calculations made with this formula. The values of n, as given in the table, were obtained from the consideration that for each place the excess of the observed temperature at the equator over that of the place, was proportional to $1-\cos n$lat. H was taken = ·814 = hor. intensity at latitude 25° on west coast of Africa. The temperature at the equator on the west coast of Africa was taken at 27°·85. The difference between this and the temperature at latitude 25°, was obtained by means of the table given on page 215, by sup-

posing, what the table shows to be true, that the difference varies from one latitude to another proportionally to $1-\cos 2\text{lat}$.

TABLE VIII.

Place.	Hor. Intensity. Computed.	Hor. Intensity. Observed.	Diff.	n
Lat. 25°, W. coast of Africa,		·814		
Christiania,	·454	·437	+·017	1·5
Moscow,	·504	·504	·000	1·5
Edinburgh,	·464	·446	+·018	1·6
Göttingen,	·480	·510	—·030	1·75
London,	·488	·485	+·003	1·7
Berlin,	·510	·509	+·001	1·6
Paris,	·523	·518	+·005	1·7
Milan,	·530	·571	—·041	1·85
Marseilles,	·538	·543	—·005	1·95
Lat. 35°, W. coast of Africa,	·665	·650	+·015	2·
Lat. 30°, do. do.	·743	·746	—·003	2·
Lat. 20°, do. do.	·878	·823	+·055	2·
Lat. 10°, do. do.	·961	·900	+·061	2·
Lat. 0°, do. do.	·991	·920	+·071	2·

The value of n was assumed the same for Moscow as for Christiania. A direct calculation from the observed temperature at Moscow gives $n=1$ (nearly), and horizontal intensity $=\cdot 6$ (nearly). For London n was assumed the same as for Paris. This accords with the general law of variation of temperature in these latitudes. The actual variation of temperature between Paris and London is less than this law requires.

The results which are given in Tables IV. to VIII, seem fully to establish that the horizontal intensity is a function of the temperature of the place; and those of Table IV. indicate that it is very nearly proportional to the temperature estimated from a point on the scale of the Centigrade thermometer 15° below the zero. This point is within 2° of the zero of Fahrenheit. We have therefore this curious and important result, viz. that the horizontal magnetic intensity is nearly proportional to the mean annual temperature of the place, as measured by a Fahrenheit's thermometer. The zero of Fahrenheit is very nearly the temperature which obtains at the two cold poles. At these poles also the horizontal intensity is very feeble. The result just stated will then accord with the fundamental principle of our theory of the magnetic forces, that the magnetic intensity of each particle of the earth's mass is proportional to the intensity of its heat, if we make this modification in the statement of this principle, viz. that the magnetic intensity is nearly proportional to the intensity of the heat over and above that which obtains at the poles of maximum cold. The real state of the case would probably be better represented by supposing that the magnetic intensity of the particles of the earth decreases more rapidly than the absolute intensity of heat, and becomes comparatively feeble at the zero of Fahrenheit, without becoming absolutely zero at this, or per-

haps any other known temperature. We shall see hereafter that it is not necessary to suppose that the molecular magnetic force becomes zero at the magnetic poles, in order to explain the fact of the horizontal intensity becoming reduced to zero there.

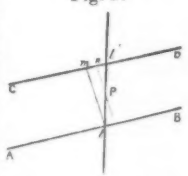
Vertical Intensity.

The formula obtained for the vertical intensity is,

$$\text{Ver. intensity} = C(t - t') \quad . \quad . \quad (16.)$$

C being a constant, and t, t', the mean annual temperatures at two places situated at certain equal distances north and south of the given place, in a direction perpendicular to the isogeothermal line, or rather line of equal molecular magnetic intensity. t and t' in the formula are in general the measures of the molecular magnetic intensities; and it is assumed that the temperatures may be taken as these measures. Since the temperatures t and t' cannot in general be readily obtained from existing observations, we will seek for the law of variation of $t - t'$. It has already been seen that the diminution of temperature from the equator northward, on the western continent, is as $1 - \cos 2\text{lat.} - C$. Now, for a small number of degrees north and south of the given place, C may be considered as constant; and hence the difference of temperature of two places situated the same number of degrees, say 5°, to the north and south of the given place, is proportional to $\cos 2(\text{lat.} - 5°) - \cos 2(\text{lat.} + 5°)$. This is equivalent to the generally received law that the temperature varies, for a moderate distance, as the square of the cosine of the latitude. For $\cos^2\text{lat.} \propto 1 + \cos 2\text{lat}$, and hence, putting d and d' equal to the variations of temperature between the given place and the two places in question, and l = latitude of given place, $d \propto (1 + \cos 2(l - 5°)) - (1 + \cos 2l)$, $d' \propto (1 + \cos 2l) - (1 + \cos 2(l + 5°))$. Whence $d + d' \propto \cos 2(l - 5°) - \cos 2(l + 5°)$. This is the measure of the variation of temperature on a meridian passing through the place. To obtain the variation in a direction perpendicular to the isogeothermal line, we must increase this in the proportion of cosine of the angle included between this perpendicular and the geographic meridian to unity. For, let P, Fig. 9, be the given place, lPl' the meridian through P, AB and CD two parallel isogeothermal lines at equal distances from P, and lm a perpendicular to AB and CD. The variation of temperature for a given distance will be as much greater in the direction lm than in the direction ll', as lm is less than ll'. But $lm : ll' :: \cos l'lm : 1$. We may take for the approximate value of $l'lm$ the declination of the magnetic needle. If therefore we denote this by d, we have, by substitution in formula (16),

Fig. 9.



$$\text{Ver. intensity} = C\frac{\cos 2(l-5^\circ)-\cos 2(l+5^\circ)}{\cos d}.$$

Or, designating by V the observed vertical intensity at some particular place, by L the latitude of this place, and by D the declination of the needle there, we have

$$\text{Ver. intensity} = V\frac{\cos 2(l-5^\circ)-\cos 2(l+5^\circ)}{\cos 2(L-5^\circ)-\cos 2(L+5^\circ)}\cdot\frac{\cos D}{\cos d} \quad \ldots (17.)$$

It was remarked on page 10, of this volume, that it might be found necessary to increase the results of formula (16), except in high latitudes, by reason of the deviation of the change of temperature from the supposed law of uniformity. If any term or factor is to be added to formula (17) on this account, it must be some function of the differential of $\cos^2 l$, that is, of $\sin 2l$.

In the calculation of the following table, V was taken equal to 1·7236 = vertical intensity at New York; except for St. Louis, Dubuque, Louisville, and Hudson, (the first result,) whose vertical intensities were computed from that of Cincinnati (1·643.)

TABLE IX.

Place.	Ver. Intensity. computed.	observed.	Diff.	Place.	Ver. Intensity. computed.	observed.	Diff.
New York,		1·7236		Cincinnati,	1·705	1·643	+·062
Montreal,	1·766	1.758	+·008	Prairie du Chien,	1·690	1·707	−·017
Dorchester,	1·747	1·720	+·027	Dubuque,	1·685	1·690	−·005
Springfield,	1·743	1·755	−·012	Louisville,	1·633	1·646	−·013
Albany,	1·741	1·744	−·003	St. Louis,	1·649	1·636	+·013
Providence,	1·742	1·741	+·001	Lat. 35°, E. coast			
West Point,	1·734	1·757	−·023	of U. States,	1·638	1·648	−·010
New Haven,	1·731	1·706	+·025	Lat. 30°, do. do.	1·510	1·479	+·031
Princeton,	1·719	1·725	−·006	Lat. 25°, do. do.	1·335	1·314	+·021
Philadelphia,	1·714	1·716	−·002	Lat. 20°, W. In-			
Washington,	1·696	1·690	+·006	dia Isles,	1·120	1·160	−.040
Hudson, Ohio,	1·657	1·727	−·070	Lat. 10°, E. coast			
do. do.	1·721	1·727	−·006	of S. America,	·600	·771	−·171

South of latitude 20°, the difference becomes large. For this three reasons may be assigned. 1. Errors in the "observed" elements obtained by estimation. 2. The deviation of the change of temperature from uniformity. 3. The inaccuracy, in the vicinity of the equator, of the supposed law, that the variation of temperature is proportional to the variation of the cosine of twice the latitude; for this law supposes that on each meridian the temperature has its maximum value at the equator, whereas Captain Duperrey has found that the warmest point of each meridian is the point of intersection with the magnetic equator. This is probably the principal source of the errors in low latitudes. The magnetic equator traverses South America at a distance of some 10° south of the geographical equator; and thus in low latitudes on the western continent, the computed vertical intensities ought to come out considerably too small. In the calculations which follow, for the eastern continent, (Table X,) this source of error

does not exist, since the magnetic equator crosses the geographical equator very near the coast of Africa.

We have seen that for the coast of Europe, and of Africa, the excess of the mean temperature at the equator over that at any latitude l, is proportional to $1-\cos nl$; n having various values at different latitudes, intermediate between 2 and 1·5. This makes the formula for the vertical intensity in western Europe and Africa,

$$\text{Ver. intensity} = \mathrm{V}\frac{\cos n(l-5^\circ)-\cos n(l+5)}{\cos n(\mathrm{L}-5^\circ)-\cos n(\mathrm{L}+5^\circ)}\cdot\frac{\cos \mathrm{D}}{\cos d}.$$

This formula gives results too small in the lower latitudes. It can however be made to represent the observations by introducing the factor $\frac{1+\sin n\mathrm{L}}{1+\sin nl}$. This being done, we have

$$\text{Ver. intens.} = \mathrm{V}\frac{\cos n(l-5^\circ)-\cos n(l+5^\circ)}{\cos n(\mathrm{L}-5^\circ)-\cos n(\mathrm{L}+5^\circ)}\cdot\frac{\cos \mathrm{D}}{\cos d}\cdot\frac{1+\sin n\mathrm{L}}{1+\sin nl}\cdot \quad (18.)$$

Whether the introduction of this factor is due to the fact that the variation of temperature is not uniform from 5° south to 5° north of the given place, as supposed in the investigation of the formula, (becoming necessary here because of the more northern situation of the magnetic equator,) or to some other cause, I have not yet undertaken to determine. It is important to observe that this factor although empirically introduced, is still a function of the differential variation of temperature. For the diminution of temperature in passing from the equator to any latitude l, is proportional to $1-\cos nl$. The differential of this, or the differential variation of temperature, is $\sin nl\,.\,ndl$. In obtaining the results given in the following table, V was at first taken equal to 1·2445, the observed vertical intensity at Paris, L = 48° 50′, and D = 22°. The vertical intensity for latitude 25°, western coast of Africa, was then calculated by the formula, and found to be 1·007. The other determinations were subsequently obtained by giving this value (1·007) to V, and taking L = 25°, and D = 20°. So that the calculations were all virtually made from the observed intensity at Paris. The same values of n were used as in the calculations of the horizontal intensities, (see Table VIII.)

TABLE X.

Place.	Ver. Intensity. computed.	observed.	Diff.	Place.	Ver. Intensity. computed.	observed.	Diff.
Paris, . .		1·2445		Berlin, . .	1·266	1·268	−·002
Lat. 25°, W. coast of Africa, .	1·007	1·014	−·007	Milan, . .	1·188	1·159	+·029
Christiania, .	1·330	1·353	−·023	Marseilles, .	1·175	1·174	+·001
Edinburgh, .	1·351	1·340	+·011	Lat. 35°, W. coast of Africa,	1·133	1·126	+·007
Göttingen, .	1·223	1·257	−·034	Lat. 10°, do. do.	·579	·631	−·052
London, . .	1·284	1·282	+·002	Lat. 0°, do. do.	0	0	·000

The differences between the results of computation and observation, both in this and the previous table, cannot but be regarded

as remarkably small, when it is considered that these are first determinations in which the nicest attention to accuracy would have been misplaced. The same may be said of the determinations of horizontal intensity and declination. The differences in Tables IX and X, might be made still smaller by making the calculations from a greater number of observed intensities.

An elaborate discussion can alone decide the question of the origin of the small differences (not due to errors of observation) that exist between the computations of vertical and horizontal intensities and declinations, and the observed values of the same:—determine whether they are not attributable (partially or entirely) to thermal differences between the magnetic crust of the earth and the air, variations in the constitution of this crust in passing from one point to another, &c., or are referable to small deviations of the theory from the truth.

Dip and Total Intensity.

The total intensity, or directive force of the needle, may be obtained by taking the square root of the sum of the squares of the horizontal and vertical intensities; and the dip by dividing the vertical by the horizontal intensity. The quotient will be the tangent of the dip. The error of total intensity will be in all instances less than the sum of the errors of the horizontal and vertical intensities. Denoting by E the error of vertical intensity and by d the dip of the needle, the error (e) entailed upon the total intensity by this, will be $e = \mathrm{E} \sin d$. The error e' entailed by that of the horizontal intensity will be $e' = \mathrm{E}' \cos d$. The total error will then be nearly $\mathrm{E} \sin d + \mathrm{E}' \cos d$. This error, except in very low latitudes where the formula for the vertical intensity is theoretically inaccurate, is every where less than 0·1, and generally only a few hundredths. Denoting the total intensity by M, we have, tangent of error of dip due to $\mathrm{E} = \frac{\mathrm{E} \cos d}{\mathrm{M}}$; and, tangent of error of dip due to $\mathrm{E}' = \frac{\mathrm{E}' \sin d}{\mathrm{M}}$. Hence, tangent of total error of dip $= \frac{\mathrm{E} \cos d - \mathrm{E}' \sin d}{\mathrm{M}}$ (nearly.) Without going into a detailed calculation, it may be seen that the error of the dip cannot exceed 4°, (except near the equator on the western continent, where the formula for the vertical intensity is theoretically inaccurate;) and is generally very much less than this.

It has been ascertained, from a discussion of the observations which have been made upon the intensity and dip, that the intensity is not a function of the dip; or that the intensity is not necessarily the same, though the dip is the same. This fact shows that the horizontal and vertical components of the inten-

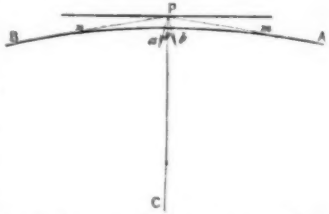
sity cannot be functions of the same element; for, if they were, when this element remained the same, both these forces would remain the same, and thus both the dip and intensity would be unaltered. The isoclinal and isodynamic lines would therefore coincide. It accords therefore, with the theory under discussion, since, upon this theory, one of these forces is a function of the absolute temperature at the place, and the other of the variation of temperature. Now, while the absolute temperature is the same at two different places, the variation of temperature may be different.

Magnetic Poles.—Magnetic Equator.

The true magnetic poles of the earth are the points on its surface where the dip of the needle is 90°; and where, therefore, the horizontal intensity is equal to zero. The existence of such points may be attributed *à priori*, to either of the two following named causes: 1. The magnetic intensity of the particles of the earth in the immediate vicinity of the place, to whose action the horizontal intensity is due, may be so feeble as to afford no appreciable horizontal force in comparison with the vertical force, which, as it depends upon the difference of the molecular intensities north and south of the place, has no necessary connection with the absolute molecular intensities. 2. The acting forces may be so related in direction and intensity that their horizontal actions may destroy each other.

We have already had reason to suppose that the absolute magnetic intensities of the particles of the earth are very feeble at the poles of maximum cold, which are in the immediate vicinity of the magnetic poles, so called, and perhaps identical with them. But, whether this be true or not, it may easily be shown that the disposition of the forces is such at these points as to make the horizontal intensity disappear, or nearly so. Let AB, fig. 10, represent a great circle passing through p, one of the cold poles. If we suppose that the temperature increases by equal degrees in every direction from p, or in other words, that the isogeothermal lines are circles traced around p, the magnetic intensity of the two particles m and n, equally distant from p, is the same. Now the acting forces of these particles will have the directions P a and P b, equally inclined to the vertical P C. The same is true of every other pair of similarly situated particles. The directive force of the needle at p will therefore be vertical. The supposition that the isogeothermal lines are circles, in the vicinity of the

Fig. 10.



cold poles, is doubtless not strictly true; nor have they probably the precise form of any curve disposed symmetrically around p, and therefore the point where the dip is 90° ought not to be in perfect coincidence with the pole of greatest cold. In fact it is conceivable that the distribution of temperature may be such that the needle will no where have the dip of 90°. This would seem to be the case at the Asiatic pole.

Agreeably to the theory which has been propounded, the magnetic equator is the line traced through all the points at which the difference of temperature on the north and south is equal to zero; for at all such places the vertical intensity and therefore the dip would be equal to zero. Now it may be presumed that the places where the difference of temperature is equal to zero, are the warmest points on the different meridians; and, in fact, according to Captain Duperrey, these are precisely the points which lie on the magnetic equator.

Pole of Maximum Intensity.

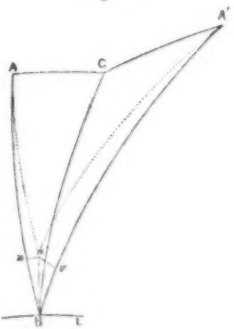
According to Sabine's Chart of Isodynamic Lines, the American pole of maximum magnetic intensity is situated in longitude 90° to 96°, and latitude 50° to 55°. Professor Locke, of Cincinnati, made in the year 1838, &c., a series of observations, which led to the more accurate determination of this point. The result to which he arrived, is that the pole of maximum intensity is situated about in long. 90°, and latitude $47\frac{1}{2}$°; or nearly on the same meridian with the pole of greatest dip, and about 20° south of it. Let us attempt to determine the situation of this point from theoretical considerations.

In the first place let it be observed that the horizontal intensity decreases from the equator northward, while the vertical intensity increases; the one varying with the temperature and the other with the difference of temperature. It follows from this that the pole of maximum intensity will be situated on the meridian on which the greatest difference of temperature obtains, provided this difference also occurs at a lower latitude than the greatest difference upon any other meridian; for the maximum vertical intensity will then be associated with a greater horizontal intensity than is the greatest vertical intensity upon any other meridian. The presumption is that the greatest difference of temperature occurs on the meridian which contains the pole of greatest cold, since there is a greater variation of temperature from the equator to the latitude of the cold pole (70° to 75°), on this than on any other meridian. We may naturally expect also, that the point of maximum variation will occur farther to the south, upon this meridian. The truth of these presumptions may be established by deriving from Brewster's formula for the temperature, a general expression for the variation of temperature in a direction

perpendicular to the isothermal line. It has already been seen that the general expression for the variation of temperature answering to an indefinitely small change of place is,

$$d'T = \frac{Cn\,(\cos\delta \sin\delta' d\delta + \cos\delta' \sin\delta d\delta')}{\sin^{-n+1}\delta \sin^{-n+1}\delta'} \quad . \quad . \quad (19.)$$

Fig. 11.



Let C, fig. 11, be the geographical pole, A, A′ the two cold poles, A being the American pole, BL the direction of the isogeothermal line at B, B*n* an arc perpendicular to BL and *nu*, *nv* arcs perpendicular to AB and A′B. Let $Bn = k$ and denote the angles AB*n* and A′B*n* by b and b'. Then $d\delta = Bu = Bn \cos ABn = k \cos b$; and $d\delta' = Bv = Bn \cos A'Bn = k \cos b'$. Substituting in equation (19),

$$d'T = \frac{Cn(\cos\delta \sin\delta' k \cos b + \cos\delta' \sin\delta\, k \cos b')}{\sin^{-n+1}\delta \sin^{-n+1}\delta'} \quad . \quad (20.)$$

$$\text{And } d\,T \propto \frac{\cos\delta \sin\delta' \cos b + \cos\delta' \sin\delta \cos b'}{\sin^{-n+1}\delta \sin^{-n+1}\delta'} \quad . \quad . \quad (21.)$$

Now the calculations of the declination which have been made, show that b and b' diminish (along with the angle ABA′) and thus cos b and cos b' increase as we follow the same parallel of latitude from the meridian of Paris, westward, as far as longitude 90° to 100°, (for example, for London $b = 12°\ 55'$, $b' = 34°\ 17'$, and for longitude 93° W., and latitude 50°, $b = 0$ and $b' = 3°$); also that δ' remains the same while δ diminishes, and that δ' is greater than δ, and is nearly equal to the colatitude of the place $+25°$. The tendency of the changes of cos b and cos b' is to make the expression (21) for $d'T$ greater in proportion as we draw nearer to the meridian 93°, or thereabouts. Omitting cos b and cos b', the numerator becomes $\cos\delta \sin\delta' + \sin\delta \cos\delta' = \sin(\delta + \delta')$. This will be the greatest when $\delta + \delta' = 90°$; and since δ' remains the same on the same parallel of latitude and δ diminishes with the angle ABA′, as we go westward towards the meridian 93°, it is plain that $\delta + \delta'$ will be equal to 90° at the lowest latitude on, or near, the meridian where the angle ABA′ is equal to zero. At this point the numerator of the fractional expression (21) is greater than at the same latitude, or at any latitude, on any other meridian; for it is only on this meridian that cos b and cos b' may be regarded as equal to unity. It is only necessary then, to establish that on each meridian the greatest value of $d'T$ obtains where $\delta + \delta' = 90°$, and that a greater value obtains at this point

on or near the meridian of 93° than on any other meridian. We will attempt to establish the latter first. Let us suppose that $b=b'$, and that each has the value of the smaller of the two. This supposition is an unfavorable one, since it will make the value of $d'T$ for other meridians than 93° greater than expression (21) makes it. Upon this supposition (21) becomes

$$\frac{\cos b(\cos\delta\sin\delta'+\sin\delta\cos\delta')}{\sin^{-n+1}\delta\sin^{-n+1}\delta'}=\frac{\cos b\sin(\delta+\delta')}{\sin^{-n+1}\delta\sin^{-n+1}\delta'}, \qquad (22.)$$

and for the point where $\delta+\delta'=90°$,

$$\frac{\cos b}{\sin^{-n+1}\delta\sin^{-n+1}\delta'};\text{ or }\frac{\cos b}{\sin^{\frac{1}{9}}\delta\sin^{\frac{1}{9}}\delta'}, \quad . \quad . \quad (23.)$$

putting $n=\frac{8}{9}$, the value which accords best with the observations of temperature. Now making the calculation of the declination for the latitude 50°, and longitude 93° W., by formula (6), I find $\delta=24°\ 40'$, $\delta'=63°\ 56'$, $b=0$ (very nearly), $b'=3°$, $\delta+\delta'=88°\ 36'$. The same calculation for London (latitude 51° 31′) gives $\delta=37°\ 18'$, $\delta'=62°\ 29'$, $b=12°\ 55'$, $b'=34°\ 17'$, $\delta+\delta'=99°\ 47'$. The point where $\delta+\delta'=90°$ is then in latitude 50° (nearly), on the meridian 93° W. For other meridians it is north of 50°. This is evidently the case for the meridian of London; and that it is true for other meridians, east or west of 93°, appears from the fact, deducible from the various calculations of declination and temperature, that while δ' remains the same on the same parallel of latitude, δ diminishes towards 93°. On these meridians then δ' is a certain number of degrees less, and δ the same number of degrees greater than on the meridian of 93°, at the point for which $\delta+\delta'=90°$. The effect of the increase of δ upon the value of expression (23) will more than compensate for that of the diminution of δ'; and the augmented value of b, by making $\cos b$ less, will increase the difference. It appears, therefore, that (23) has its maximum value in the vicinity of 93° of longitude; —on the meridian for which the angle between δ and δ' is zero. The details of the calculations of declination make it evident that this meridian, and therefore that of maximum value, lies a few degrees to the west of 93°.

We have still to show that the maximum value of expression (21), on each meridian, is at the point where $\delta+\delta'=90°$. In longitude 93° this value of $\delta+\delta'$ occurs about in latitude 50°. For this locality and its vicinity $b=0$ (very nearly), and $b'=$ some 3° or 4°. In going north from 50° to 60°, b is constantly from 4′ to 5′, and b' increases about $2\frac{1}{2}°$. In going south b preserves about the same value, while b' diminishes; as may be seen from the fact that at St. Louis (long. 90° 15′, lat. 38° 37′) the sum of the two angles b and b' does not exceed 10′. Now, let us suppose that $b=b'$ in expression (21), which will give

$$\frac{\cos b' \sin(\delta+\delta')}{\sin^{-n+1}\delta \sin^{-n+1}\delta'} \quad . \quad . \quad . \quad (24.)$$

For the point where $\delta+\delta'=90°$ this becomes

$$\frac{\cos b'}{\sin^{-n+1}\delta \sin^{-n+1}\delta'} \quad . \quad . \quad . \quad (25.)$$

(25) is less than the value of (21) for latitude 50°. South of this latitude let us suppose that $b'=b$ in (21), which gives

$$\frac{\cos b \sin(\delta+\delta')}{\sin^{-n+1}\delta \sin^{-n+1}\delta'} \quad . \quad . \quad . \quad (26.)$$

(26) is greater than (21) south of 50°. If therefore we show that (26) is less than (25), we shall have established that (21) decreases south of 50°. The denominator of (26) is greater than that of 25. It will only be necessary then to show that the numerator of (26) is less than that of (25). At 50°, $b'=3°$, and $\cos b' = \cos 3° = \cdot 99863$. b may be regarded as zero. The details of the calculations of declination show that the variation, due to a change of latitude, of $\delta+\delta'$ is more than twice the change of latitude. Thus, while $\delta+\delta'$ is equal to $88\frac{1}{2}°$ at latitude 50°, at latitude 60° it is equal to 66°, and at St. Louis (lat. $38\frac{1}{2}°$) it is 113°. Thus at latitude 47°, 3° south of 50°, the numerator of (26) is less than $\sin 96° = \cdot 99452$. It follows therefore that (21) diminishes, as we follow the meridian 93° south from the latitude of 50°. North of 50° the increase of b' tends to diminish (21). Dropping b', (b being equal to zero,) we have

$$\frac{\sin(\delta+\delta')}{\sin^{-n+1}\delta \sin^{-n+1}\delta'} \quad . \quad . \quad . \quad . \quad (27.)$$

Whether this fraction, and consequently (21), will increase or diminish, depends upon the value given to n. If we suppose $n=\frac{5}{6}$ as approximately determined by Brewster, or $\frac{6}{9}$, there will be a continual increase from 50° northward. But, as we have already seen, the observations of temperature are best satisfied by taking $n=\frac{8}{9}$, and at the same time $t=31°$ and $\tau=-18°$. This will be more evident on inspecting the following table calculated from the formulæ

$$T=\left(28°-(-19°)\right)\left(\sin^{\frac{3}{4}}\delta \sin^{\frac{3}{4}}\delta'\right)-19°$$

$$T=\left(30°-(-17°)\right)\left(\sin^{\frac{7}{8}}\delta \sin^{\frac{7}{8}}\delta'\right)-17°$$

$$T=\left(31°-(-18°)\right)\left(\sin^{\frac{8}{9}}\delta \sin^{\frac{8}{9}}\delta'\right)-18°.$$

TABLE XI.

Place.	Temperatures. $n=\frac{3}{4}$	observed	Diff.	Temperatures. $n=\frac{7}{8}$	observed	Diff.	Temperatures. $n=\frac{8}{9}$	observed	Diff.
Lat. 61°, Lon. 93° W.	−6°·6	−8°·0	+1°·4	−7°·1	−8°·0	+0°·9	−8°·0	−8°·0	0°·0
Lat. 55°, do. do.	−1 ·5	−2 ·5	+1 ·0	−2 ·2	−2 ·5	+0 ·3	−2 ·8	−2 ·5	−0 ·3
Lat. 50°, do. do.	3 ·3	2 ·5	+0 ·8	2 ·9	2 ·5	+0 ·4	2 ·5	2 ·5	0 ·0
Tschernoljes, .	−5 ·0	−7 ·0	+2 ·0	−5 ·6	−7 ·0	+1 ·4	−6 ·4	−7 ·0	+0 ·6
Stretensk, . .	4 ·0	3 ·0	+1 ·0	3 ·9	3 ·0	+0 ·9	3 ·5	3 ·0	+0 ·5
Moscow, . .	5 ·0	4 ·4	+0 ·6	4 ·4	4 ·4	0 ·0	4 ·1	4 ·4	−0 ·3
Urga, . . .	6 ·9	6 ·0	+0 ·9	6 ·4	6 ·0	+0 ·4	6 ·2	6 ·0	+0 ·2
Berlin, . . .	9 ·7	8 ·8	+0 ·9	9 ·4	8 ·8	+0 ·6	9 ·3	8 ·8	+0 ·5
Washington, .	11 ·9	12 ·7	−0 ·8	11 ·8	12 ·7	−0 ·9	11 ·8	12 ·7	−0 ·9
St. Louis, . .	12 ·6	13 ·0	−0 ·4	12 ·6	13 ·0	−0 ·4	12 ·6	13 ·0	−0 ·4
The Azores, .	15 ·6	16 ·0	−0 ·4	15 ·9	16 ·0	−0 ·1	15 ·6	16 ·0	−0 ·4
Havana, . .	22 ·5	25 ·0	−2 ·5	23 ·7	25 ·0	−1 ·3	24 ·4	25 ·0	−0 ·6

Now making $n=\frac{8}{9}$, and making the calculations for various latitudes north of 50°, I find that expressions (27) and (21) remain very nearly constant. The value of (21) does not vary more than 0·01 from 50° to 60° of latitude. If we suppose n to be a very small fraction greater than $\frac{8}{9}$, then (21) will decrease from 50° northward. In fact, that (21) will decrease for n nearly equal to unity may at once be seen by considering that, when $n=1$, (21) is reduced to its numerator.

For other meridians than 93°, or thereabouts, the diminutions of cos b and cos b' are greater in going north, and thus (21) diminishes north of the point where $\delta+\delta'=90$, even for $n=\frac{8}{9}$. To determine the variation of (21) south of this point, we will take the same expressions (25) and (26) as for the meridian of 93°. On either side of this meridian b and b' increases, but b' is continually greater than b. If we take the meridian for which b', at the point of $\delta+\delta'=90°$, is equal to 10°, it appears that on this meridian $\delta+\delta'$ varies for any change of latitude an amount equal to about twice the latitude. This will be evident on comparing the facts for the meridian of 93° with the statement that for New York, for the meridian of which b' at the point above mentioned is about 20°, $\delta+\delta'$ is equal to $105\frac{1}{2}°$. It follows, therefore, that for the meridian assumed, 5° south of the point at which $\delta+\delta'=90°$, the numerator of (26) is less than sin 100° = ·90481, while the numerator of (25) = cos 10° = ·90481. The denominator of (26) is greater than that of (25). Hence (26) is less than (25). Whence it appears that (21) diminishes south from the point where $\delta+\delta'=90°$, or from very near this point. For meridians at a distance from 93° a detailed calculation is necessary to make out distinctly that (21) diminishes southward. We may avoid this calculation by establishing that, south of the points at which $\delta+\delta'=90°$, (21) is greater for the meridian of 93° (or rather for the meridian a little to the west of this on which the angle between δ and δ' is zero) than for every such meridian, at every considerable latitude. By making unfavorable

suppositions we obtain from (21) for the meridian 93° the expression $\frac{\cos b' \sin(\delta+\delta')}{\sin^{-n+1}\delta \sin^{-n+1}\delta'}$, and for any other meridian the expression $\frac{\cos b \sin(\delta+\delta')}{\sin^{-n+1}\delta \sin^{-n+1}\delta'}$. Now for the same latitude δ is less for 93°, or thereabouts, than for any other meridian, while δ' is the same; and therefore south of the point of maximum on 93°, or of latitude 50°, the numerator of the fraction $\frac{\sin(\delta+\delta')}{\sin^{-n+1}\delta \sin^{-n+1}\delta'}$ is greater and denominator less, and therefore the fraction itself greater upon this meridian than any other. Again near this meridian b' for 10° south of 50° is less than 2°; and some 15° from it the value of b exceeds this amount. The maximum value of (21) for the meridian of 93° is then greater than its value at the same latitude (50°) on any other meridian, or at any lower latitude. We have also before made out that it is greater than the value on another meridian at the point for which $\delta+\delta'=90°$, or any where to the north of this. It only remains then to show that it is greater than any value between this point and 50°. The expression for the maximum value in question is $\frac{1}{\sin^{-n+1}\delta \sin^{-n+1}\delta'}$, and that for the value of (21) between the two points just mentioned is $\frac{\cos b \sin(\delta+\delta')}{\sin^{-n+1}\delta \sin^{-n+1}\delta'}$. We have already seen that the denominator of the first fraction is less than that of the second for each of the two points in question. As the denominator of the second gradually decreases from one point to the other, it follows therefore that it is continually greater than that of the first. Hence between these points the second fraction is less than the first.

We conclude therefore that the pole of maximum intensity is situated about in latitude 50°, and longitude 93° to 100°.

In what precedes, it has been supposed that expression (21) is rigorously true, but in its investigation no account was taken of the motion of the fictitious cold poles. The error from this cause is trifling, except at considerable distances from the cold poles, and cannot vitiate the result just obtained. Our conclusions with respect to the situations of the points of greatest intensity on distant meridians, may not be strictly correct, from this cause.

A more elaborate discussion will be necessary to fix the precise value of n for all parts of the earth. It is not improbable that it may be necessary in expression (21) to assign different values to n for different quarters of the earth, varying from $\frac{3}{4}$ to 1. In fact

(21) cannot be made to extend to the cold poles except by supposing n there equal to unity.

If we consult a chart of isothermal lines, we find the greatest variation of temperature to be set down for about longitude 90° W., and latitude 45°; and that this occurs at a lower latitude than the maximum variations on other meridians: which nearly accords with the theoretical conclusion obtained above.

It is to be observed that all the considerable changes of total intensity in high latitudes, are almost entirely attributable to changes in the vertical intensity. In latitude 50° on this continent, the entire suppression of the horizontal intensity would not diminish the total intensity more than 0·07. On consulting Mahlmann's table of temperatures, it may be seen that the change in the variation of temperature in the direction towards the cold pole, as we go north beyond 40°, is much less than from the equator to 40°; and that the changes of temperature in this direction accord very well with the changes of magnetic intensity in high latitudes upon this continent, as exhibited by Sabine's chart.

GENERAL RESULTS.

The following points appear to have been conclusively established by the foregoing discussion.

1. All the magnetic elements of any place on the earth, may be deduced from the thermal elements of the same; and all the great features of the distribution of the earth's magnetism may be theoretically derived from certain prominent features in the distribution of its heat.

2. Of the magnetic elements, the horizontal intensity is nearly proportional to the mean temperature as measured by a Fahrenheit's thermometer; the vertical intensity is nearly proportional to the difference between the mean temperatures at two points situated at equal distances north and south of the place, in a direction perpendicular to the isogeothermal line; and, in general, the direction of the needle is nearly at right angles to the isogeothermal line, while the precise course of the inflected line to which it is perpendicular may be deduced from Brewster's formula for the temperature, by differentiating and putting the differential equal to zero.

3. As a consequence, the laws of the terrestrial distribution of the physical principles of magnetism and heat must be the same, or nearly the same; and these principles themselves must have towards one another the most intimate physical relations.

4. The principle of terrestrial magnetism, in so far as the phenomena of the magnetic needle are concerned, must be confined to the earth's surface, or to a comparatively thin stratum of the mass of the earth.

5. The mechanical theory of terrestrial magnetism which has been under discussion, must be true in all its essential features.

6. We may derive the magnetic elements by very simple formulæ, and with an accuracy equal to that of Gauss's formulæ, from a very small number of magnetic data determined by observation, and the mean annual temperature of the place.

The great importance of these results cannot well be questioned. Whether or not they be regarded as supporting the theoretical views of the physical nature of magnetism which have been briefly alluded to, they cannot fail, it would seem, to throw some additional light upon this hitherto mysterious subject. They also link together in the closest bonds of union, the two sciences of Terrestrial Magnetism and Meteorology, and confer a new value upon the observations made in each of these two great departments of science.

Art. XIX.—*Notice of Dr. Mantell's Isle of Wight.**

While mentioning this new work of Dr. Mantell, we can respond to the sentiment of Scott † In earlier years we visited the "beautiful island," and found in it the most remarkable features —topographical, geological, picturesque and agricultural: while in connexion with the vicinal coast of Dorset, Hampshire and Sussex, it is full of interesting historical associations. Upon this coast the Romans first made their landing—the Saxons, Danes, and Normans followed, and it is easy to understand that the geological events recorded in the strata, and the historical events that have clustered on the surface, may combine to impart to this region peculiar attractions. It lies on the narrow channel which divides England from France, and in a climate which is regarded as the mildest in Great Britain.

This region is rich in the fossil treasures of the tertiary, the chalk, and the Wealden; and Dr. Mantell has done much to explore and make known the geology of the S.E. of England. The science is greatly indebted to him for his very able works on local geology, as well as for his comprehensive Survey of the Wonders of Geology, and of the Medals of the Creation.

The present work is a large 12mo., of the size of the Medals; it contains 430 pages, and is illustrated by 20 plates, including a geological map of the Isle of Wight, and 36 lignographs or

* Geological Excursions round the Isle of Wight and along the adjacent coasts of Dorsetshire, illustrative of the most interesting geological phenomena and organic remains. By Gideon Algernon Mantell, Esq., LL.D., F.R.S., Author of "The Medals of the Creation," "Thoughts on Animalcules," &c.

† "That beautiful island, which he who once sees never forgets, through whatever part of the wide world his future path may lead him."—*Sir Walter Scott.*

wood-cuts. It is got up in the same elegant style of paper and typography as the Medals, and is intended as a companion both to the tourist and the geologist. The Isle of Wight, long a favorite resort of travellers and invalids, is now for a part of the year, the residence of the royal family, and of course presents new attractions to a loyal people. The work of Dr. Mantell is therefore in harmony with the era, and as we understand, meets a wide demand.

Although the Isle of Wight is visited by the general traveller with particular reference to its picturesque scenery, it possesses, in the language of the author, still stronger claims to the attention of the natural philosopher, for, the strata of which it is composed present phenomena of the highest interest, which elucidate some of the most important pages in the earth's physical history. Notwithstanding the publications of Sir H. Englefield, Mr. Thomas Webster, and other able observers, and of the models of Captain Ibbetson, it is affirmed by the author that the majority of the inhabitants, and that thousands of intelligent strangers who annually traverse the island, pass unconsciously over a country "rich in the spoils of nature and teeming with objects of the highest interest to the instructed observer." This deficiency of knowledge is supplied in the work before us, and its usefulness is not confined to the travellers in this small island, since the phenomena here recorded and the fossils here observed and described, and the conclusions drawn, have an important bearing upon the geology of similar regions found in other countries. It is difficult to give an analysis of a work whose leading topics are necessarily local. Some principal features may however be presented with due prominence. The chalk formation is ably illustrated: in this the author is peculiarly at home, as he was born and lived most of his life among the chalk downs and cliffs, and is familiar both with the upper and the lower chalk, forming together with the associated strata, masses of one thousand feet in thickness in the deepest beds.

In the instructive summary of the author:—

The character of the cretaceous system is that of an ocean-bed, formed in a vast basin by successive accumulations of sedimentary detritus, transported by currents, and thrown down in the tranquil depth of the sea; arenaceous and argillaceous deposits prevailed in the lower, and cretaceous in the upper division of the series; periodical intrusions of heated fluids charged with silex having taken place at uncertain intervals. The fossils prove that the ocean swarmed with innumerable beings of the usual orders of vertebrate and invertebrate marine organisms, belonging for the most part to species and genera now unknown; and in the chalk are seen, for the last time, that numerous tribe of Cephalopoda, the ammonites, of which, so far as our knowl-

edge at present extends, not a single species is known either in the tertiary strata or in more recent deposits: with the chalk the whole race of the *ammonites* disappeared. With respect to the vegetable kingdom of the cretaceous period, the presence of numerous marine fuci attests the nature of the marine flora; and the fragments of drifted coniferous wood, fir-cones, stems and leaves, which are found in the flint and chalk in some localities, prove that the dry land was clothed with pine forests and cycadeous plants. The occasional discovery of bones and teeth of reptiles, shows that the islands and continents were tenanted by oviparous quadrupeds. Of birds and mammalia not a vestige has been discovered.

The Wealden Formation, so ably investigated by Dr. Mantell and other English geologists on the opposite coast of England, has been fully made out in the Isle of Wight, and we may therefore presume that it is continuous beneath the English channel. The clays and fresh-water limestones and beds of lignite of the Wealden, are found at Sandown and Compton bays in this island, and the limestones contain both bivalves and univalves. Petrified trees are found in great abundance at Brook Point, sometimes retaining the ligneous structure, at other times in the form of a coally black matter or filled with pyrites. The trees are all lying postrate and appear to have been accumulated under water like the rafts of the Mississippi. Some of the trees lying along the shore are three feet in diameter, and appear to have been covered when in a state of maturity. Two stems were traced to a length of twenty feet, and indicated trees from forty feet to fifty feet long while living. The annual and annular lines of growth are often very distinct, and bear a close resemblance to the Auracaria or Norfolk Island pine. Thirty or forty have been traced on a single stem; they are all of unequal thickness, thus indicating the variation of the seasons in heat and moisture. The wood was mineralized by calcareous and not by siliceous matter, and the bark was generally turned into lignite.

"In the clays for several hundred yards, both to the east and west of Brook Point, bones of the Wealden reptiles are numerous; with these are associated large mussel shells and lignite."

Among the fossil reptiles the bones of the colossal Iguanodon are conspicuous, an animal whose former existence was first proved by Dr. Mantell. These bones are washed out by the sea and strewed along the shore, subject to the destroying action of the waves, and are in general water-worn masses of bone indicating the enormous magnitude of the animals to which they belonged. The bones are generally impregnated with iron—often garnished with brilliant crystals of pyrites, and the medullary cavities filled with calcareous spar. The bones collected within the last few years in Sandown, Brixton, Brook, and

Compton bays must have belonged to one hundred and fifty or two hundred individuals, and they prove that the country then teemed with colossal viviparous quadrupeds, some of them indicating animals more gigantic than even those of Tilgate forest.

On the shores of this island, bones are found of all the well known Wealden reptiles, the Iguanodon, Hylæosaurus, Megalosaurus, and Streptospondylus, besides the Cetiosaurus and Plesiosaurus. Dr. Mantell estimates the entire length of the fossil thigh and leg bone found in Sandown bay to have been over nine feet. A toe bone measured six inches long and fifteen in circumference.

The body of the Iguanodon must have been equal in magnitude to that of the elephant, and its limbs of proportionate size. One of the thigh bones in the British Museum if suitably invested with muscles and integuments, would form a limb seven feet in circumference.

The animal was a vegetable eater, and probably found its food among the palms, ferns, cicadeæ and coniferæ of that era. The hinder extremities, massive and unwieldy, resembled those of the hippopotamus or rhinoceros, and were supported by a very strong short* foot furnished with claws like those of some turtles.

Although the bones of the extremities of the Iguanodon were six or eight times larger than those of the most gigantic alligator —the whole length appears not to have exceeded thirty feet, supposing the head to have been about three feet long with a short neck and the tail thirteen feet—the trunk would be about twelve feet, which is much more than is seen in any living animal. It is thought that the body may have been twelve or fifteen feet high, and must have presented a monstrous appearance unlike to that of any existing animal.† Remains of the Hylæosaurus and Megalosaurus are also found in the Isle of Wight—the latter about thirty feet long and the former of half that length.

Bones of the Cetiosaurus or whale-like lizard—of the Streptospondylus or lizard with reversed vertebræ, the ball being placed anteriorly upon the vertebra, and bones of the Plesiosaurus, have also been found in this island.

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* Short in proportion to the colossal bulk of the animal; but a single separate bone of the foot has been found to measure thirty inches in length, and the last joint of the toe to which a claw was attached, was five and a half inches long. —*Ansted's Ancient World*, p. 212.

† The elephant rarely attains the height of eleven feet. Eleven hundred elephants, examined on a particular occasion in India, did not present a single individual of eleven feet in height.—*Ansted's Ancient World*, p. 213, note.

The Iguanodon, Megalosaurus and Hylæosaurus appear to have formed a peculiar group of land lizards—the first herbivorous—the second carnivorous, and the last not yet determined.

The 12th and last chapter of Dr. Mantell's work contains a detailed notice of the geology and topography of the neighboring coast, which abounds with interesting and instructive facts, among which the petrified forest of the oolite of the peninsula of Portland is one of the most remarkable.

The retrospect which closes the volume is so fine a specimen of geological induction that we insert it entire.

"In attempting to interpret the natural records of the earth's physical history, the geologist is often in the condition of the antiquary who endeavors to decipher an ancient manuscript, in which the original characters are obscure and partially obliterated by later superscriptions. It is, indeed, frequently difficult, and sometimes impossible, to determine the synchronism of those geological changes, of which the only indications are insulated and but obscurely related phenomena. Bearing in mind the caution of a distinguished philosopher, 'that the language of theory can never fall from our lips with any grace or fitness, unless it appear as the simple enunciation of those general facts with which by observation alone we have become acquainted,' we will take a retrospective view of what has been advanced, and endeavor to deduce therefrom some general results as to the nature of those physical mutations, of which we have obtained such unequivocal proofs. Fortunately, the evidence of the important changes which the organic and inorganic kingdoms of nature have undergone in this part of the globe, during the vast periods embraced by our researches, is so conclusive, that the attentive reader will perceive the following inferences, startling as they may appear, naturally result from the facts that have been submitted to his observation.

"I. *The Oolitic Epoch.*—The most ancient deposits comprehended in our Excursions, are the upper beds of an oceanic formation of great extent—the *Oolite*—which is characterized by numerous peculiar species and genera of marine reptiles, fishes, mollusks, radiaria, corals, zoophytes, &c. With these strata are intercalated in some places, deposits of variable extent and thickness, containing carbonized vegetable remains, and the stems and foliage of palms, arborescent and herbaceous ferns, cycadeous plants, and coniferæ; with bones and teeth of terrestrial reptiles, and of marsupial and insectivorous mammalia, associated with vestiges of insects. These beds are evidently attributable to the action of rivers and streams, by which the spoils of the land were transported into the abyss of the ocean. But our present survey only refers to the period when a portion of the bed of the Oolitic sea was elevated above the waters,

and constituted an island clothed with pine-forests and cycadeous plants.

"II. *The Wealden Epoch.*—The country with its pine-forests was gradually submerged, and formed the beds of estuaries and bays, into which land floods, loaded with sedimentary detritus, deposited mud, silt, and sand, abounding in the remains of freshwater mollusks and crustaceans; in which from occasional irruptions of the sea, were intercalated layers of oysters, and estuarine shells. Bones and teeth of terrestrial reptiles, and of river fishes, with stems and fragments of coniferous wood, were also drifted into the estuaries and bays by the streams and rivers. The gradual subsidence of the sea-bottom covered by these freshwater beds continued, and the sediments acquired an exclusively fluviatile character, till at length the accumulated deposits of a vast river formed an extensive delta, many hundred feet in thickness, upon the inferior strata. The imbedded organic remains attest, that throughout this epoch the fauna and flora of the country through which the river flowed, corresponded with those of the islands and continents of the Oolitic period.

"III. *The Cretaceous Epoch.*—The commencement of this era was marked by the subsidence of the entire era now occupied by the greensand formation, to a depth sufficient to admit of the accumulation of the deep sea deposits, of which the greater part of the cretaceous beds of England, and of the adjacent portion of the European continent, consist. The Wealden sediments were submerged to a great depth, and upon them were deposited sands, and argillaceous mud, and calcareous detritus, teeming with marine exuviæ. But the ocean of the chalk extended far beyond the limits of the Wealden; it buried beneath its waters a considerable portion of modern Europe, and its waves reached the New World, and covered part of the continent of North America. This ocean swarmed with numerous forms of marine organisms, belonging in a great measure to species and genera unknown in the earlier, and in the later geological epochs. The interspersions of freshwater deposits containing terrestrial exuviæ, though inconsiderable, prove that although the delta of the country of the Iguanodon was submerged in the abyss of the ocean, a group of islands, or a continent, inhabited by that colossal reptile and its contemporaries, and covered with pine-forests, cycadeæ, and ferns, flourished up to a late period of the cretaceous epoch.

"IV. *The Tertiary Epoch.*—The bed of the chalk ocean was broken up, and considerable areas were elevated above the sea, and covered with vegetation, and tenanted by pachydermata and other mammalia; the dry land of Europe during this period was less extensive than at the present time.

"In the basins and depressions formed by the submerged portions of the cretaceous strata, new sediments began to take place; the sea which deposited them teeming with marine animals, distinct from those of the preëxisting ocean. Localintrusions of freshwater deposits, abounding in the spoils of the land and its inhabitants, denote the existence of islands or continents, tenanted by mammalia allied to the tapir, elephant, rhinoceros, horse, deer, &c.; and the vegetable remains consisting of palms and dicotyledonous trees, indicate an approach to the flora of the warm regions of the south of Europe. A few reptiles, principally of the alligator and crocodilian types, and lizards of small size, appear as the representatives of the swarms of colossal oviparous quadrupeds of the previous epochs.

"V. *The Pre-historic Epoch.*—From the most recent tertiary deposits, to those in which occur the remains of animals which seem to have always been contemporary with the human race, the transition is imperceptible. But elevatory movements, and subsidences, more or less general, appear to have continually taken place, by which the relative position of the land and sea was subjected to repeated oscillation. During this period, large pachyderms, as the mammoth, mastodon, hippopotamus, rhinoceros, &c.—several species of horse—gigantic elks and deer—and many carnivora, as the lion, tiger, bear, hyena, &c.—inhabited the European continent and islands. While this fauna prevailed, a succession of terrestrial disturbances occurred, by which the physical configuration of the land was materially changed. England and its islands were separated from the continent; and to this epoch is probably referable the formation of the lines of elevation, that traverse the districts over which our observations have extended.

"*Lastly.*—Man took possession of the land, and such of the large mammalia as had survived the preceding geological revolutions, were either exterminated by his agency, or reduced to a domesticated state. Subsequently to the occupation of these islands by the aboriginal tribes, the country has undergone no important physical mutations. The usual effects of the atmosphere, the wasting of the shores by the encroachments of the sea, the erosion of the land by streams and rivers, the silting up of valleys, and the formation of deltas, are apparently the only terrestrial changes to which England and its islands have been subjected during the historic ages.

"*Corollary.*—From this examination of the geological phenomena of the southeast of England, we learn that at a period incalculably remote, there existed in the northern hemisphere an island or continent, possessing a climate of such a temperature, that its surface was covered with arborescent ferns, palms, cycadeæ, and other coniferæ; and the ocean that watered its shores,

was inhabited by turtles and marine lizards of extinct genera. This country suffered a partial subsidence, which was effected so tranquilly, that many of the trees retained their erect position, and the cycadeous plants, and a considerable layer of the vegetable mould in which they grew, remained undisturbed. In this state an inundation of freshwater covered the country and its forests, and deposited upon the soil and around the trees a calcareous mud, which was gradually consolidated into limestone; thermal streams, holding flint in solution, percolated the mass, and silicified the submerged trees and plants.

"A further subsidence took place, floods of freshwater overwhelmed the petrified forest, and heaped upon it accumulations of detritus, which streams and rivers had transported from the land. The country traversed by the rivers, like that of the submerged forest, enjoyed a tropical climate, and was clothed with palms, arborescent ferns, and cycadeæ; it was tenanted by gigantic herbivorous and carnivorous reptiles, and its waters abounded in turtles, and various kinds of fishes and mollusca. The bones of the reptiles, the teeth and scales of the fishes, the shells of the mollusca, and the stems, leaves, and seed-vessels of the trees and plants, were brought down by the streams, and imbedded in the mud of the delta, beneath which the petrified forest was now buried.

"This state continued for an indefinite period—another change took place—the Country of Reptiles with its inhabitants was swept away, and the delta, and the fossil trees with the marine strata on which they once grew, subsided to a great depth, and formed part of the bottom of a profound ocean; the waters of which teemed with countless myriads of zoöphytes, shells, and fishes, of species long since extinct. Periodical intrusions of thermal streams charged with silex, gave rise to layers and veins of nodular and tabular flint, and occasioned the silicification of the organic remains subjected to their influence.

"This epoch, which was of long duration, was succeeded by elevatory movements, by which the bottom of the deep was broken up, and large areas were slowly upheaved; and as the elevation continued, the deposits which had accumulated in the depths of the ocean approached the surface, and were exposed to the action of the waves. These masses of cretaceous strata now began to suffer destruction, and the delta of the country of the Iguanodon gradully emerged above the waters; and finally the petrified forest of the Oolite rose in the midst of the sea, and became dry land. At length some portions of the elevated strata attained an altitude of several hundred feet, and a group of islands was formed; but in the basins or depressions beneath the waters, sediments derived from the disintegration of the sea-cliffs were deposited. Large herbivorous mammalia now inhabited

such portions of the former ocean-bed as were covered with vegetation sufficient for their support; and as these animals died, their bones became enveloped in the accumulations of mud and gravel, which were forming in the bays and estuaries.

"This era also passed away—the elevatory movements continued—other masses of the bed of the chalk ocean, and of the Wealden strata beneath, became dry land—and at length those more recent deposits containing the remains of the herbivorous mammalia which were the last tenants of the country. The oak, elm, ash, and other trees of modern Europe, now sprang up where the groves of palms and tree-ferns once flourished—the stag, boar, and horse, ranged over the plains in which were entombed the bones of the colossal reptiles—and finally, *Man* appeared, and took possession of the soil.

"At the present time, the deposits containing the remains of the mammoth and other extinct mammalia, are the sites of towns and villages, and support busy communities of the human race; the huntsman courses, and the shepherd tends his flocks on the elevated masses of the bottom of the ancient chalk ocean—the farmer reaps his harvests upon the cultivated soil of the delta of the country of the Iguanodon—and the architect obtains from beneath the petrified forest, the materials with which to construct his temples and his palaces: while from these various strata, the geologist gathers together the relics of the beings that lived and died in periods of unfathomable antiquity, and of which the very types have long since been obliterated from the face of the earth, and by these natural memorials is enabled to determine the nature and succession of those physical revolutions, which preceded all history and tradition."

Art. XX.—*Seventeenth Meeting of the British Association for the Advancement of Science.**

"The order of Proceedings at this Seventeenth Meeting of the British Association," (held at Oxford on Wednesday, the 23d of June, and the week thereafter,) "was much the same as on former occasions, with such varieties only as the locality induced. We give our usual summary. On Wednesday, the General Committee assembled. On Thursday, the work of the Sections began; and Prof. Powell lectured in the Radcliffe Library, on Shooting Stars. On Friday evening, Prof. Faraday delivered, at

* From the London Athenæum, Nos. 1026 and 1027, June 26, and July 3, 1847. The superior interest of the Address of the President of the British Association, at its late meeting, requires the omission of some other matter, which will be inserted in a future number.

the same place, a lecture on the subject of new discoveries in Electricity and Magnetism. Saturday morning was occupied in excursions to Swindon, Shotover Hill, and Blenheim—and boat excursions on the Isis to Moreham, where the Archbishop of York had thrown open his grounds to the Association. For those who preferred business, there was a meeting of the General Committee in the morning, at nine; and meetings afterward in the mathematical and chemical Sections. In the evening there was a conversational *soirée* at the Taylor buildings. On Sunday, the Bishop of Oxford preached a Sermon at St. Mary's, which we understand will shortly be printed, at the request of some leading members of the Association; and in the evening, Prof. Powell held a *soirée* at his house. On Monday, the proceedings in some of the Sections were enlivened by the presence of Prince Albert, who arrived in the morning, accompanied by the Duke Saxe Weimar; and in the evening, Mr. Strickland delivered at the Radcliffe Library, a conversational lecture on the Dodo, and the Dean of Westminster some Geological Remarks. On Tuesday, after the sectional meetings, there was an evening exhibition of Microscopes at the Radcliffe Library. On Wednesday morning, the members of the General Committee gave a breakfast in the hall of Christ Church to the foreign visitors of the Association—and several of the Sections met for business. At one o'clock the concluding meetings of the General Committee were held for the purpose of sanctioning the grants which had passed the Committee of Recommendations; and at three, the concluding general meeting of the Association assembled to pass the customary votes of thanks."

On Wednesday afternoon, at three o'clock, the general meeting convened to hear the speech of Sir Roderick Impy Murchison, on retiring from the chair. "Sir R. H. Inglis then took the chair, and after a brief pause delivered the following address:—

THE PRESIDENT'S ADDRESS.

"May it please you, Mr. Vice Chancellor, Sir Roderick Murchison, Gentlemen of the British Association:—When I consider the attainments of the distinguished person whom I succeed in this chair, I might well shrink from a position which places me in any degree in comparison with him: and when I look back on the array of the most illustrious names in science of this age and nation, some of whom add civil and social rank to the eminence which they have acquired by their personal labors, and who have in succession been your presidents, I feel far more strongly than I can express, the undeserved honor which was most unexpectedly conferred upon me when the Council desired to nominate me to my present position. Though in early years, when I enjoyed more leisure, I took such interest as I could in some branches of natural philosophy and in chemistry,—and though I look back to those opportunities with the most grateful recollection of their value

and of the pleasure which I derived from them,—(it is my own fault if I did not derive profit, also, from Kidd in this place, and from Playfair and from Hope in Edinburgh,)—my occupations have, for the larger portions of my life, been such as to prevent my persevering in the pursuits which most of those before me have continued to follow, to their own honor among their fellow men and to the benefit of our common country.

"It has been the practice of former presidents to address the first general meeting of the Association on the progress of science during the preceding year, and on its state and prospects in the present. Sir Roderick Murchison, my eminent friend, who did honor to this chair, took a comprehensive grasp of all the objects which this duty placed within his reach. When I read his Address, I felt, even more than before, my unfitness to follow him; but such as I am, you have selected me to succeed to his position and his duties; and I shall endeavor to discharge my functions with as little discredit to your choice as may be in my power. Whatever may be good in the observations which follow this exordium, will be owing to my friends, the Rev. Dr. Robinson, Prof. Owen, Mr. Robert Brown, and Colonel Sabine. Anxious as I am not to disgrace your judgment in placing me where I am, I am still more anxious not to assume a merit which does not belong to me; and, therefore, unfeignedly begging you to attribute to the sources which I have pointed out, whatever may in detail interest you in the continuation of my Address, I am content with the distinction of calling such men my personal friends.

"I begin with ASTRONOMY.—The progress of astronomy during the past year has been distinguished by a discovery the most remarkable, perhaps, ever made as the result of pure intellect exercised *before* observation,—and determining *without* observation the existence and force of a planet; which existence and which force were subsequently verified *by* observation. It had previously been considered as the great trial and triumph of dynamical science, to determine the disturbances caused by the mutual action of 'the stars in their courses,' even when their position and their orbits were fully known; but it has been reserved for these days to reverse the process, and to investigate from the discordance actually observed, the existence and the place of the wondrous stranger which had been silently, since its creation, exerting this mysterious power. It was reserved for these days to track the path and to measure the force which the great Creator had given to this hitherto unknown orb among the myriads of the air.

"I am aware that Lalande, more than fifty years ago, on two nights —which, if he had pursued the object then first discovered, would have been well distinguished from the rest of the year, and would have added new glory to his own name—did observe what is now fully ascertained to have been the planet Neptune; but though Uranus had just been added to those bright orbs which to mortal eyes for more than two thousand years have been known to circle our sun, Lalande was observing before Piazzi, Olbers, and Harding had added Ceres, Pallas, Juno and Vesta to that number, and before by those discoveries it was proved, not only that the planets round the sun had passed the mystic number of seven—since Herschel had confuted that ancient belief—

but that others might also remain to reward the patient labors of other observers. He therefore distrusted his own eyes; and preferred to believe that he had been mistaken, rather than that the existence and force of a new planet had been reserved for the discovery of this latter age. What his eyes saw, but what his judgment failed to discriminate and apply, has since become a recognized fact in science.

"I will not presume to measure the claims of the two illustrious names of Leverrier and Adams; of him, who, in midnight workings and watchings, discovered the truth in our own country, and of the hardly happier philosopher who was permitted and enabled to be the first, after equal workings and watchings, to proclaim the great reality which his science had prepared, and assured him to expect. I will trust myself with only two observations: the one, my earnest hope that the rivalry not merely of the illustrious Leverrier and of my illustrious countryman, Adams, but of the two great nations which they represent, France and England, respectively, may always be confined to pursuits in which victory is without woe, and to studies which enlarge and elevate the mind, and which, if rightly directed, may produce alike glory to God and good to mankind: and the other, my equal hope, that for those (some of whom I trust may now hear me) who employ the same scientific training and the same laborious industry which have marked the researches of Leverrier and Adams, there may still remain similar triumphs in the yet unpenetrated regions of space; and that—unlike the greater son of a great father—they may not have to mourn that there are no more worlds to be conquered.

"It is a remarkable fact, that the seeing of the planet Neptune was effected as suddenly at Berlin by means of one of the star-maps which has proceeded from an association of astronomers chiefly Germans; such maps forming in themselves a sufficient illustration of the value of such Associations as our own, by which the labor and the expense—too great, perhaps, for any one individual—are supplied by the combined exertions of many kindred followers of science.

"It is another result of the circulation of these star-maps, that a new visitor, a comet, can hardly be within the range of a telescope for a few hours, without his presence being discovered and announced through Europe. Those comets which have been of larger apparent dimensions, or which have continued longer within view, have, in consequence, for more than two thousand years been observed with more or less accuracy; their orbits have been calculated; and the return of some has been determined with a precision which in past ages exercised the wonder of nations;—but now, improved maps of the heavens, and improved instruments, by which the strangers who pass along those heavens are observed, carry knowledge where conjecture lately dared not to penetrate. It is not that more comets exist, as has sometimes been said, but more are observed.

"An Englishman—a subject of this United Kingdom—cannot refer to the enlarged means of astronomical observation enjoyed by the present age, without some allusion to the noble Earl, Lord Rosse, one of the Vice Presidents of this day, who, himself educated amongst us here in Oxford, has devoted large means and untiring labor to the completion of the most wonderful telescope which science, art, and wealth

have ever yet combined to perfect; and which the Dean of Ely—a man worthy to praise the work—pronounced to be a rare combination of mechanical, chemical, and mathematical skill and knowledge. Its actual operations have been suspended by a cause not less honorable to Lord Rosse in another character, than the conception and early progress of his great instrument were to him as a man of science. They have been retarded, so far as he himself is concerned, by the more immediate and, I will say, higher duties which, as a magistrate, as a landowner, and as a Christian gentleman, he owed, and has been paying to his neighbors, his tenantry, and his country, during the late awful visitation which has afflicted Ireland. Yet perhaps my noble friend will permit me to say, that while we not only do not blame him—we even praise him cordially for having devoted his time, his mind, and his wealth to those claims which could not be postponed, since they affected the lives of those who in God's providence surrounded him—there were, and there are others, two at least in his own country, and one his most illustrious friend, Dr. Robinson, (but I speak without any communication on the subject from that great observer and greater philosopher,) who might have carried on the series of observations which this wonderful telescope alone can effect, and might thus have secured for his own division of the empire, the discovery of the planet Neptune.

"The Catalogues of Lacaille and the Histoire Céleste are now before the world; and with the Catalogue of our Association, constitute a series of most important gifts conferred on astronomy. I have already said that I will not presume to measure the relative merits of two eminent individuals;—it is as little within my power to measure the value of such gifts to science. That value can be duly appreciated by none but the great masters of this, the greatest of the sciences: but I may be permitted to add, that here, also, come into beneficial action the powers and the uses of such an association, which, rising above the mere calculations of pecuniary profit, provides for the few who only are capable of extracting the just benefit from such works, those materials of advancing knowledge which are beyond the reach of individuals.

"The Astronomer Royal has done me the honor and the kindness, by a paper which I have just received from him, to make me the vehicle of communicating his wisdom to you on a most important and interesting discovery of the past year.

"'In the lunar theory a very important step has been made in the course of the past year. When near the beginning of the present century, a considerable number of the Greenwich lunar observations were reduced by Bürg for the purpose of obtaining elements for the construction of his Lunar Tables, and generally for the comparison of the moon's observed place with Laplace's theory, it was found impossible to reconcile the theoretical with the observed places except by the assumption that some slowly varying error affected the epoch of the moon's mean longitude. From the nature of the process by which the errors of the elements are found, the conclusion upon the existence of this peculiar error is less subject to doubt than that upon any other error. So certain did it appear, that Laplace devoted to it one entire chapter in the *Mécanique Céleste*, with the title 'On an inequality of

long period by which the moon's mean motion appears to be affected.' Guided by the general analogy of terms producing inequalities of long period, he suggested as its probable cause an inequality whose argument depends upon a complicated combination of the longitude of the earth's perihelion, the longitude of the moon's perigee, the longitude of the moon's node, and the moon's angular distance from the sun. But he made no attempt to calculate its theoretical effect. He also suggested an inequality depending on a possible difference in the northern and southern hemispheres of the earth. Many years elapsed before these suggested theoretical inequalities were carefully examined by physical astronomers. At length the introduction of new methods enabled Poisson and Lubbock successfully to enter upon the investigation of the theoretical values; and they proved that inequalities depending on the arguments suggested by Laplace could not have sensible values. The theory was now left in greater doubt than ever; and suspicion fell even on the accuracy of the reductions of the observations.

"'A few years since, as is well known to members of the British Association, the British Government, at the representation of the Association, sanctioned the complete reduction, on an uniform plan, of all the observations of the moon made at the Royal Observatory of Greenwich since the year 1750: and the immediate superintendence of this work was undertaken by the Astronomer Royal. The reductions are now printing in all necessary detail; and the press-work is at this time very far advanced. In the last summer the corrections of the elements of the moon's orbit were generally obtained; and the errors of epoch in particular at different times were found with great accuracy. These results confirmed those of Bürg, and extended the law of the inequality to a much later time. In this state they were exhibited by the Astronomer Royal, to Prof. Hansen of Gotha, who was known to be engaged in the Lunar Theory. Prof. Hansen immediately undertook a search for their theoretical causes. His perfect knowledge of the state of the existing theories enabled him at once to single out the class of disturbances produced by the action of the planets as that in which the explanation of this inequality would probably be found. In the course of a systematic search, many inequalities of long period were found; but none of sensible magnitude. At length two were found, both produced by the disturbing force of Venus, of a magnitude entirely unexpected. One depends upon the circumstance, that eighteen times the mean anomaly of Venus diminished by sixteen times the mean anomaly of the Earth, increases at very nearly the same rate as the mean anomaly of the Moon: its co-efficient is 27″ and its period two hundred and seventy-three years. The other depends upon the circumstance, that eight times the mean anomaly of Venus increases at very nearly the same rate as thirteen times the mean anomaly of the Earth: its co-efficient is 23″ and its period two hundred and thirty-nine years. The combination of these two explains almost perfectly the error of epoch, which had so long been a subject of difficulty. The discovery of these two inequalities, whether we regard the peculiarity of their laws, the labors expended upon the investigations, or the perfect success of their results, must be regarded as the most important step made in physical astronomy for many years.'

"The doctrine of the influence of the moon and of the sun on the tides was no sooner established, than it became eminently probable that an influence exerted so strongly upon a fluid so heavy as water, could not but have the lighter and all but imponderable fluid of air under its grasp. I speak not of the influence attributed to the moon in the popular language and belief of nations ancient and modern,—of Western Europe and of Central Asia, in respect to disease; but of the direct and measurable influence of the moon and of the sun in respect to the air. It is now clear, as the result of the observations at St. Helena by my friend Col. Sabine, that as on the waters, so on the atmosphere, there is a corresponding influence exerted by the same causes. There are tides in the air as in the sea; the extent is of course determinable only by the most careful observations with the most delicate instruments; since the minuteness of the effect, both in itself and in comparison with the disburbances which are occasioned in the equilibrium of the atmosphere from other causes, must always present great difficulty in the way of ascertaining the truth—and had, in fact, till Col. Sabine's researches, prevented any decisive testimony of the fact being obtained by direct observation. But the hourly observations of the barometer made for some years past at the Meteorological and Magnetical Observatory at St. Helena, have now placed beyond a doubt the existence of a lunar atmospheric tide. It appears that in each day the barometer at St. Helena stands, on an average, four thousandths of an inch higher at the two periods when the moon is on the meridian above or below the pole, than when she is six hours distant from the meridian on either side; the progression between the maximum and minimum being moreover continuous and uninterrupted:—thus furnishing a new element in the attainment of physical truth; and, to quote the expression of a distinguished foreigner now present, which he uttered in my own house when the subject was mentioned, 'We are thus making astronomical observations with the barometer'—that is, we are reasoning from the position of the mercury in a barometer, which we can touch, as to the position of the heavenly bodies which, unseen by us, are influencing its visible fall and rise. 'It is no exaggeration to say,'—and here I use the words of my friend, the Rev. Dr. Robinson,—'that we could even, if our satellite were incapable of reflecting light, have determined its existence, nay, more, have approximated to its eccentricity and period.'

"I am unwilling to quit this subject without expressing any deep sense of the services rendered to science by the patient, laborious, unobtrusive observation and researches of my eminent friend, Col. Sabine, in meteorology, and above all, magnetism, in connection with different and very distant points of the earth: researches undertaken, some of them, before public attention was so generally called to the subject as it has been in later years—(since the British Association urged the importance of such investigation upon the government at home;) and undertaken at great sacrifice of domestic comfort, and at the risk of life, not in the ordinary duties of his noble profession, but in the persuit of science for its own sake,—science one year at the North Pole, and the next, I think, in Sierra Leone. The reputation thus acquired does not come quickly, but it comes surely, and will survive perma-

nently; and the reputation of the individual adds to the reputation of his country.

"I hardly know why, on this division of my subject more than on any other, I should recall to the notice of the meeting the address of that master mind, Dr. Robinson of Amagh, to the Monaghan Society; an address delivered to a provincial body in Ireland, which ought to be spread over the whole empire:—but as I read it with the deepest interest, as it is far too little known, and as I owe much to Dr. Robinson for the assistance which he has now intrusted to me, I am unwilling to omit this tribute of respect and gratitude.

"In concluding this sketch of the progress and state of astronomy, pardon me if I here quote a passage, which has been a favorite with me for thirty years, and which I always desire to apply as a lesson first to myself—and perhaps, though with great deference, as a lesson to others also. It is taken from a great master of the English language in the best age of English literature, Henry Peacham. He is referring, in substance, to the parallax of the fixed stars, and his illustration is to this effect:—If from two points of the earth's surface the same star appears of the same bigness, how great must be that star—how inconsiderable, the earth! His conclusion is strengthened by discoveries unknown in his age: and I may extend his truth and supply the figures which make it more striking. If at two extremities of the earth's orbit (between which extremities not less than 180,000,000 of miles intervene) there is no parallax, or the smallest measurable, between the position of a star seen from one extremity and the position of the same star seen from the other extremity, in reference to one other star or to all other stars, how infinitely great must be the distance and the size of the stars—how inconsiderable, the earth! But Peacham's application of the truth known in his own days I give in his own words:—

"'If the earth were of any quantitie in respect of the higher orbes, the starres should seeme bigger or lesse in regard of those *hypsomata* (altitudes) or the climes; but it is certaine that at the selfesame time sundrie astronomers finde the same bignesse and elevation of the selfesame starre observed by their calculation to differ no whit at all; whereby we may see, if that distance of place which is on the earth (in respect of the heavenly orbes) exceedeth all sence, it followes that the earth (poore little point as it is) seemes the like, if it be compared with heaven: yet this is that point which, with fire and sword, is divided among so many nations, the matter of our glorie, our seate; heere we have our honors, our armies, our commands; heere we heape up riches, at perpetual warre and strife among ourselves, who (like the toad) shal fall asleepe with most earth in his pawes; never thinking how of a moment of time well spent upon this poore plot or dung-hill, common to beasts as well as ourselves, dependeth eternitie and the fruition of our true happinesse in the presence of heaven, and court of the King of Kings for ever and ever.'

"The extensive and diversified field of PHYSIOLOGY presents so many objects of nearly equal interest, as to make it difficult, in a rapid sketch like the present,—and above all for one like me,—to select those which may least unworthily occupy the attention of the Association.

"In physiology, the most remarkable of the discoveries, or rather improvements of previous discoveries, which the past year has seen, is, perhaps, that connected with the labors of the distinguished Tuscan philosopher, Matteucci; who on several former occasions has coöperated with this Association in the sections devoted to the advancement of the physical and physiological sciences. I refer in this instance to his experiments on the generation of electric currents by muscular contraction in the living body. This subject he has continued to pursue; and, by the happy combination of the rigorous methods of physical experiment with the ordinary course of physiological research, Prof. Matteucci has fully established the important fact of the existence of an electrical current—feeble, indeed, and such as could only be made manifest by his own delicate galvanoscope—between the deep and the superficial parts of a muscle. Such electric currents pervade every muscle in every species of animal which has been the subject of experiment; and may, therefore, be inferred to be a general phenomena of living bodies. Even after life has been extinguished by violence, these currents continue for a short time; but they cease more speedily in the muscles of the warm-blooded than in those of the cold-blooded animals. The Association will find his own exposition of the physiological action of the electric current in his work, 'Leçons sur les Phénomènes Physiques des Corps Vivants,' 1847.

"The delicate experiments of Matteucci on the torpedo, agree with those made by our own Faraday (whom I may call doubly our own in this place, where he is a Doctor of our University) upon the *Gymnotus electricus*, in proving that the shocks communicated by those fishes are due to electric currents generated by peculiar electric organs, which owe their most immediate and powerful stimulus to the action of the nerves.—In both species of fishes the electricity generated by the action of their peculiar organized batteries—besides its benumbing and stunning effects on living animals,—renders the needle magnetic, decomposes chemical compounds, emits the spark, and, in short, exercises all the other known powers of the ordinary electricity developed in inorganic matter or by the artificial apparatus of the laboratory.

"Etherization, a kindred subject,—one to which deep and natural importance is now attached,—may not unfitly follow the mention of Prof. Matteucci's investigations.

"It is the subject of the influence of the vapor of ether on the human frame—a discovery of the last year, and one the value of which in diminishing human pain has been experienced in countless instances, in every variety of disease, and especially during the performance of trying and often agonizing operations. Several experiments on the tracts and nerve roots appropriated respectively to the functions of sensation and volition, have been resumed and repeated in connexion with this new agency on the nervous system. Messrs. Flourens and Longet have shown that the sensatorial functions are first affected, and are completely, though temporarily, suspended under the operation of the vapor of ether; then the mental or cerebral powers; and finally, the motor and excito-motor forces are abrogated. It would seem that the stimulus of ether applied so largely or continuously as to produce *that* effect is full of danger—and that weak constitutions are sometimes

unable to rally and recover from it; but that when the influence is allowed to extend no further than to the suspension of sensation, the recovery is as a general rule complete. It is this remarkable property of ether which has led to its recent application with such success as may well lead us to thank God, who, in his providemce, has directed the eminent physicians and surgeons amongst our brethren in the United States to make this discovery;—a discovery which will long place the name of Dr. Charles T. Jackson, its author, among the benefactors of our common nature.

"At the same time, much careful observation on the *modus operandi* of this most singular agent, seems still requisite before a general, systematic, safe, and successful application of it can be established for the relief of suffering humanity. So great, however, is the number of well-recorded instances of its having saved the patient from the pain of a surgical operation without any ill effect in reference to his subsequent recovery, as to make the subject of the influence of the vapor of ether upon the nervous system, and the modification of that influence on different temperaments, one eminently deserving the attention of the physiological section of the British Association.

"With regard to the functions of the primary division and parts of the brain itself, there has been of late a happy tendency to substitute observations on the modifications of those parts in the series of the lower animals in the place of experimental mutilations on a single species, in reference to the advancement of cerebral physiology. Experiment is, no doubt, in some instances, indispensable: but we ought ever to rejoice when the same end is attained by comparative anatomy rather than by experimental vivisections; and every true philosopher will concur with my most eminent friend, Professor Owen, in his doubt, (I quote his own words) 'whether nature ever answers so truly when put to the torture, as she does when speaking voluntarily through her own experiments, if we may so call the ablation and addition of parts which comparative anatomy offers to our contemplation.'—[Owen's Hunterian Lecture, Vertebrata, p. 187.]

"I was always struck with that passage in the 'Life of Sir W. Jones' in which that great man, who united so many claims to the admiration of mankind, declined to accept the offer of a friend to collect, and in collecting to put to death, a number of insects in the eastern islands, to be transmitted to Calcutta. He did not, of course, deny the value and importance, and, in one sense, the necessity, of forming such collections: but he limited the right of posessing them to those who could *use* them; and he would not have one of those, the wonders of God's animal world, put to death for the mere gratification of his own unscientific curiosity. He quotes the lines of Ferdusi, for which Saadi invokes a blessing on his spirit, and the last of which contains all my own morality in respect to the lower animals,—

> O spare yon emmet, rich in hoarded grain,
> He lives with pleasure, and he dies with pain.

I am aware that the doctrine assumed in the first line of the couplet in reference to the particular insect, is denied by some naturalists; and that the fact assumed in the last line, in reference to the lower animals, is denied by others. Whatever be the truth as to the first point, I have

no more doubt than I have of my own existence, that some of the lower animals feel severe pain: and even if the words of our immortal Shakspeare as to the corporal sufferance of the beetle trod upon be not literally accurate—yet who is entitled to affirm the contrary?—this, I think, is clear, that the child who is indulged in mutilating or killing an insect for his own pleasure, has learnt the first lesson of inhumanity to his own species.

"To revert, however, for a minute, to the principle on which true results may be obtained from the observed variations of organs in the animal series, it is in the first place essential (I speak on the authority of Professor Owen, and, of course, not on my own) to determine the parts which truly answer to those, the functions of which it is the object of the comparative anatomist to elucidate. An elaborate and valuable contribution with this aim, was communicated by Dr. Carpenter to the Physiological Section of this Association, at its meeting at Southampton; having for its subject the homologies and functions of the parts of the *encephalon*.

"It is needless to dwell on the obvious necessity of the knowledge of the essential nature,—signified by the true definition and name—of the part of the animal series, in order to insure correct reasoning on the physiological import of the varieties of such parts. The British Association has already manifested its appreciation of the value and necessity of this preliminary step in comparative physiology, by calling for the report on the homologies of the vertebrate skeleton; and that report, just published, is itself the best evidence of the importance of the subject, and a model of the mode in which it should be treated, and in which, happily for this Association, it has been treated by the Cuvier of England, Professor Owen.

"In no department of the science of organized bodies has the progress been greater or more assured, than in that which relates to the microscopic structure of the constituent tissues of animal bodies, both in their healthy and in their morbid states; and this progress is specially marked in this country during the period which has elapsed since the communication to the British Association by Professor Owen, of his researches into the intimate structure of recent and fossil teeth.

"The result of these researches having demonstrated the constancy of well-defined and clearly appreciable characters in the dental tissues of each species of animal, (by which characters such species could be determined, in many instances, by the examination of a fragment of a tooth,) other observers have been stimulated to pursue the same minute inquiries into the diversities of structure of the tissues of other organs. Such inquiries, for example, have been most ably and successfully pursued by Dr. Carpenter in reference to the microscopic structure of recent and fossil shells; and the anatomist, the naturalist, and the palæontologist, are alike indebted to the zeal and the skill of that eminent physiologist: while, in another sense, all are indebted to the British Association for aiding and stimulating his inquiries, and for the illustrations with which the publication of Dr. Carpenter's Report has been accompanied in the transactions of the Association.

"The *hairs* of the different mammalian animals offer to the microscopical anatomist a field of observation as richly and remarkably devel-

oped as the *teeth*, which formed the subject of Professor Owen's communication in 1838, and as the external coverings of the testaceous mollusca, which formed the subject of Dr. Carpenter's communication in 1846.

"The structure of the softer tissues of the animal frame has not been less successfully investigated by microscopic observers. One of the most extraordinary, perhaps, of the recent discoveries by the microscope is that which is due chiefly to Purkingé and Valentin, and which in this country has been well established by Dr. Sharpey, relative to the important part in the motion of fluids on internal surfaces, performed by the vibratile action of myriads of extremely minute hairs or cilia which beset those surfaces. These ciliary movements, for example, raise the mucus of the wind-pipe to the throat against gravity. They have been detected in the ventricles of the brain, as well as many other parts.

"Microscopic anatomy has been chiefly indebted to Ehrenberg, Remak, and Dr. Martin Barry, for the exposition of the ultimate structure of the nervous and cerebral fibres.

"Exact knowledge of the nature of the retina, or the vitreous and crystalline humors, and of other delicate constituents of the organ of vision—the most wonderful of all the organs with which God has entrusted man—has been remarkably advanced by the skilful use of the improved microscopes of the present day. I rejoice that, among the proposed arrangements of the Association at its present meeting, one evening, Tuesday the 29th, will be specially devoted to an exhibition of microscopic objects. The beautiful discoveries of Sir David Brewster (whom, in this Association, we must always mention as one of our earliest friends and patrons, three times one of our Vice Presidents,) have been carefully confirmed; and many interesting varieties have been noticed in the structure of the crystalline lens of the eyes of different species of animals.

"The most brilliant result, perhaps, of microscopic anatomical research has been the actual observation of the transit of the blood from the arteries to the veins; the last fact required—if, indeed, such an expression be allowable—for the full proof of Harvey's doctrine of the circulation of the blood. Malpighi first observed the transit in the large capillaries of the frog's web. It has since been observed in most other tissues, and in many other animals.

"No part of the animal body has been the subject of more, or of more successful, researches than the blood itself. The forms and dimensions and diversities of structure characteristic of the colored discs, corpuscles, or blood globules, as they were once termed, in the different classes, orders, and genera of animals, have been described, and for the most part accurately depicted; and through the concurrence of numerous observers, the anatomical knowledge of these minute particles, invisible to the naked eye, has become as exact and precise as the knowledge of the blood vessels themselves, or of any other of the grosser and more conspicuous systems of organs; and has added,—when we consider how easily the action is deranged, by how many causes it may be diseased or stopped,—another to the many proofs that we are fearfully as well as wonderfully made. In surveying how our

frame is formed, how sustained, how revived by sleep, one of the most wondrous of all the incidents of our nature, what suffering is produced by any pressure on the lungs, and yet how unconsciously we breathe a million times in health for one in sickness,—I cannot but feel that our Heavenly Father gave another proof of His essential character when, in answer to the prayer of Moses, 'Shew me thy glory,' God answered, 'I will cause *all my goodness* to pass before thee.'

"In no department of science has the confluence of its cultivators—at such annual meetings as the present—been more influential in advancing its progress in the right direction than in natural history.

"Natural history is preëminently the science of observation; a science made up of insulated facts and phenomena collected from the earth, the air, and the waters,—first, carefully observed, and then distributed or generalized according to resemblances and analogies. Every fact, if it be deserving such a description—that is to say, if it be truly observed and accurately stated—is welcome to the man of science, though the observer himself may not be in a condition to recognize the full signification of his own fact or its bearings on collateral phenomena. But if this be the case when one fact is communicated to one man of science, such particulars when communicated to an association like the present and discussed in its appropriate section of scientific observers, speedily gain their right place and do their duty in the steady advancement of natural science. The observer thus, for the first time, made cognizant of the full value and importance of his own observation, returns to his own locality and to his own particular department of science with renewed interest, with increased zeal, and, perhaps, also with a better direction given to his observations.

"The rapid progress of the scientific knowledge of the animals of our own islands, and the great advance in the determination of the British fauna, may be produced in illustration of the benefit which has followed these assemblages, and the encouragement which the British Association, as a body, has given to the investigation of the facts and the publication of the results.

"In no department of the living works of the Creator has this been more manifested than in that humble, and, therefore, heretofore much neglected class of the molluscous or gelatinous animals which people the seas around our island. Among the naturalists who have rescued this branch of zoology from neglect, the name of Edward Forbes deserves early and honorable mention. The stimulus given by his successful exertions with the dredge and with the towing net, in collecting new species of Conchifera, Echinoderma, and Acalepa, and the brilliant generalizations which he has deduced from the fruits of these researches, may be discerned in the beautiful monograph by Messrs. Alder and Hancock on the British Nudibranchiata, now in course of publication by the Ray Society—in the interesting work on British Zoophytes, just completed by Dr. Johnston—and in the new discoveries annually communicated to the Zoological Section of the British Association, by Dr. Allman, Dr. Thompson, and other eminent naturalists from Ireland; by Prof. Goodsir and other excellent observers in Scotland; by Mr. Price, as the fruit of his observations on the shores of Birkenhead; and by Mr. Peach from the coasts of Cornwall. But the

reports of the sectional meetings and those other reports which have been suggested or encouraged by the grants of the British Association, will best attest the influence of this Association in the promotion of natural history in general and of home zoology in particular.

"I cannot utter one or two technical terms which I have lately addressed to the meeting, without adding one passing reference to the great ancient authority from which they are derived; and which, high as its value is in its proper place in relation to those unchanged sciences of morals and mind, the cultivation of which is the distinguishing object of the academical education of Oxford, is also high even in natural science also: for, while the ethics of Aristotle remain the monument of his profound reason, his claim to eminence as a great observer of natural history remains also, after the experience of two thousand years, unshaken and unalterable.

"I proceed now to notice the science of BOTANY; which, aided in these days by the microscope, and by chemistry, as to the structure, functions and uses of the living plant, and as to the analogies in the vegetable world in its fossil state, presents one of the most interesting subjects of inquiry to the student and to the general observer.

"Systematic botany is constantly receiving additions to the number of species.

"In England, with respect to living plants, for the greater part of the accession to the plants in cultivation during the preceding year we are indebted to Mr. Fortune, the Horticultural Society's collector in China; who has recently published an account of his mission: and we are not less indebted to those who, as collectors and correspondents in various parts of the world, communicate the results of their labors to the Royal Botanic Gardens at Kew. That establishment, under the direction of my friend, Sir William Jackson Hooker, has unquestionably become the first botanic garden in Europe. I use this expression on the authority of another friend whom I have had the privilege of knowing for forty years, whom Humboldt described as *le premier Botaniste de l'Euroupe*, accurate, sagacious, and profound, and whose knowledge is only equalled by his modesty. After this, it is not for your sakes but my own, that I name Robert Brown; may I add, in passing, the expression of every one's wish that he would deposit more of his knowledge in print.

"Before I quit the subject of the great institution at Kew, I ought to mention as one of the latest accessions to it, a cactus weighing a ton, as stated by Sir W. J. Hooker, in his Report laid before Parliament; who adds, that the collection of that most singular family, so recently made familiar to us, (he refers to the collection at Kew,) 'is now unrivalled in Europe.'

"With respect to new species of plants received only in the state of specimens for the herbarium, they have been in part obtained from China, South America, and New Zealand; but chiefly from Australia. The late expedition into the interior, or at least further into the interior of that great continent than in any other direction had hitherto been made, —expeditions so creditable to the enterprise, perseverance, and intelligence of their conductors—have however been but little productive, so far as we at present know, in the department of botany. The ani-

mal productions of New Holland, so wonderful in their forms and structures, have long formed the most remarkable characteristic of its vast region; nor is its botany without distinctions of much interest, though as yet but very imperfectly explored. It may be said, however, in reference to the results of these later expeditions, which have penetrated further inland, that they have not brought to our knowledge any peculiarities in the vegetable kingdom so various and so striking as those which exist near the coasts, and which are sufficient to distinguish New Holland and the Australian colonies from the other regions of the world.

"In the diffusion of the riches of the vegetable world, steam navigation has obviously been a most favorable auxiliary; so that 'even cuttings of plants' are now 'actually sent successfully to Calcutta, Ceylon, &c.' In speaking of the exports from Kew, it is not unfitting to add, that 'between four and five thousand plants of the famous Tussae grass have been dispersed from the Royal Gardens at Kew during the past year.'

"The increase in the number of visitors to that most flourishing establishment is some evidence at least of an increase of a taste for the development of science, and probably of that increase of the love of science which it is one of the objects of the British Association to encourage in all classes.

"In 1841, the number of visitors was 9,174; but they are nearly doubling every year. In 1844, they were 15,114; in 1845, 28,139; in 1846, 46,573.

"In vegetable physiology, microscopic observers have of late been much occupied in investigating the phenomena of fecundation, and especially as to the mode of action of the pollen.

"On this subject botanists are still divided. Several experienced observers adopt the theory lately advanced and ingeniously supported by Prof. Schleiden, of Berlin; while others of great eminence deny the correctness on which this theory is founded. Among these, the celebrated microscopic observer, Prof. Amici, of Florence, very recently in an essay—communicated to the scientific meeting held in 1846 at Genoa—has endeavored by a minute examination of several species of Orchis, to prove the existence of the essential part of the embryo anterior to the application of the pollen, which, according to him, acts as the specific stimulus to its development.

"This view receives great support from some singular exceptions to the general law of fecundation.

"Of these, the most striking occurs in a New Holland shrub, which has been cultivated several years in the Botanic Garden at Kew; and which, though producing female flowers only, has constantly ripened seeds from which plants have been raised perfectly resembling the parent:—while yet there is no suspicion either of the presence of male flowers in the same plant, or of minute stamina in the female flower itself, nor of fecundation by any related plant cultivated along with it.

"This plant has been figured and described in a recent volume of the Linnean Society's 'Transactions,' under the name of *Cælebogyne ilicifolia*, by Mr. J. Smith, the intelligent curator of the Kew Garden,

by whom, indeed, this remarkably fact was first noticed. It is not the least curious part of the history of the *Cælebogyne*, that male flowers have lately been discovered in New Holland unquestionably of the same species.

"Prof. Gasparini, of Naples, has more recently communicated to the scientific meeting held in that city in 1845, his observations and experiments on the cultivated fig, which, though entirely detitute of male flowers, produced seeds having a perfectly developed embryo, independent of fecundation; access to the pollen of the wild fig, generally supposed to be carried by insects, being, in his experiments, prevented by the early and complete shutting up of the only channel in the fig by which it could be introduced.

"An elaborate memoir has very recently appeared in the Transactions of the Linnean Society, by the late Mr. W. Griffiths, 'On the Structure and Affinities of Plants Parasitical on Roots.' These singular productions have been regarded by several distinguished botanists as forming one natural class which they have called *Rhizanthea*. Mr. Griffiths, on the other hand, who was eminently qualified, both as a systematic and physiological botanist, to judge of such a question, has adopted the opposite view taken by other observers, namely, that these plants really belong to several distinct, and not even nearly related, families; the points of internal structure and external appearance which they have in common arising from the peculiar mode in which they receive their nourishment.

"The extension of the means of communication by the Electric Telegraph is yearly facilitating intercourse, almost as rapid as light or as thought, between distant portions of England, and between distant provinces in the vast empire of our Queen.

"The last pamphlet which I had in my hand before leaving home yesterday, was a Report presented to the Legislative Council and Assembly of New Brunswick, relative to a project for constructing a railway, and with it a line of electro-magnetic telegraph, from Halifax to Quebec.

"Distance is time; and when by steam, whether on water or on land, personal communication is facilitated, and when armies can be transported without fatigue in as many hours as days were formerly required, and when orders are conveyed from one extremity of an empire to another almost like a flash of lightning, the facility of governing a large state becomes almost equal to the facility of governing the smallest. I remember, many years ago, in the *Scotsman*, an ingenious and able article showing how England could be governed as easy as Attica under Pericles; and I believe the same conclusion was deduced by William Cobbet from the same illustration.

"The system is daily extending. It was, however, in the United States of America that it was first adopted on a great scale, by Prof. Morse in 1844; and it is there that it is now already developed most extensively. Lines for above 1,300 miles are in action; and connect those States with Her Majesty's Canadian Provinces; and it is in a course of development so rapid, that, in the words of the report of Mr. Wilkinson, to my distinguished friend, his Excellency Sir W. E. Colebrooke, the governor of New Brunswick, to which I have just adverted,

'No schedule of telegraphic lines can now be relied upon for a month in succession, as hundreds of miles may be added in that space of time. So easy of attainment does such a result appear to be, and so lively is the interest felt in its accomplishment, that it is scarcely doubtful that the whole of the populous parts of the United States, will, within two or three years, be covered with a telegraphic network like a spider's web, suspending its principal threads upon important points along the sea-board of the Atlantic on one side, and upon similar points along the lake frontier on the other.' I am indebted to the same Report for another fact, which I think the Association will regard with equal interest. 'The confidence in the efficiency of telegraphic communication has now become so established, that the most important commercial transactions daily transpire, by its means, between correspondents several hundred miles apart. Ocular evidence of this was afforded me by a communication a few minutes old, between a merchant in Toronto and his correspondent in New York, distant about six hundred and thirty-two miles.' I am anxious to call your attention to the advantages which other classes also may experience from this mode of communication, as I find it in the same Report. When the *Hibernia* steamer arrived in Boston, in January, 1847, with the news of the scarcity in Great Britain, Ireland, and other parts of Europe, and with heavy orders for agricultural produce, the farmers in the interior of the state of New York, informed of the state of things by the magnetic telegraph, were thronging the streets of Albany with innumerable team-loads of grain almost as quickly after the arrival of the steamer at Boston as the news of that arrival could ordinarily have reached them. I may add, that, irrespectively of all its advantages to the general community, the system appears to give already a fair return of interest to the individuals or companies who have invested their capital in its application.

"The larger number of the members of this Association have probably already seen in London an exhibition of a patent telegraph, which prints *alphabetical* letters as it works. Mr. Brett, one of the proprietors, obligingly showed it to me; and stated that he hoped to carry it into effect on the greatest scale ever yet imagined on the American continent. Prof. Morse, however, does not acknowledge that this system is susceptible of equality with his *telegraphic* alphabet for the purpose of rapid communication; and he conceives that there is an increased risk of derangement in the mechanism employed.

"I cannot refer to the extent of the lines of the electric telegraph in America without an increased feeling of regret that in our own country this great discovery has been so inadequately adopted. So far, at least, as the capital is concerned, the two greatest of our railway companies have not, I believe, yet carried the electric telegraph further from London than to Watford and Slough: an enterprise measured in the United States by hundreds of miles being measured by less than scores in England.

"In England, indeed, we have learnt the value of the electric telegraph as a measure of police in more than one remarkable case: as a measure of government it is not less important;—from the illustration which I have drawn from America, it is equally useful in commerce; but as a measure almost of social intercourse in the discharge of public business, it is not without its uses also. The day before yesterday I had an opportunity of examining the telegraph in the lobby of the House

of Commons, by which communications are made to and from some distant committee-room. As a specimen of the information conveyed from the House is the following:—'Committee has permission to sit until five o'clock;' and among the questions sent down from the committee are the following:—'What is before the House?' 'Who is speaking?' 'How long before the House divides?'

"Even if I possessed in myself, or had collected from others, the materials for the most rapid sketch of the progress of other sciences, the time would fail me in the attempt to convey it to you. I abstain from any reference to geology, principally from my own ignorance of its later progress. I can as little endeavor to bring before the Association the discoveries during the past year by which science has ministered to the arts or to commerce; yet I cannot leave altogether unnamed—though I can hardly do more than name—the discovery of the gun-cotton, and the application of electricity to the smelting of copper.

"For that process, I believe, a patent has been recently taken out. As yet, perhaps, sufficient time has not elapsed to test its full value. We all know that an experiment succeeds perfectly in the case of a model, or in a laboratory, which may not succeed so perfectly when the miniature steam-engine, for example, is extended to its ordinary size in a manufactory, or when the operation is transferred from ounces to tons. But if the hopes, expectations, and confidence of the discoverers be realized, their plan will be of the greatest value to this country, and of even greater proportionate value to some of the Queen's most important colonies. It has been said that 10,000 tons of copper were sent last year from Australia, to be smelted in England; and that they produced no more than 1,600 tons of copper. It is evident, therefore, that, if by this process of smelting by electricity, the refuse, namely, 8,400, can be left on the spot, 8,400 tons of shipping are liberated for other purposes of commerce between the colony and the mother country; and the saving of coal in England, an object not wholly devoid of interest, is immense.

"From the sciences cultivated, extended, or encouraged, I advert to a consideration of the Association itself. The importance of these meetings is national. Their direct results have been eminently beneficial to science; their indirect effects in uniting men of the same pursuit from different parts of our common country, and not less in bringing together those whom seas and empires divide, but whom the same zeal for knowledge happily associates as in this place, are equally remarkable. Those antipathies (I hardly use too strong a word) which once separated us from our brethren in other realms—and from which even men of science were not always exempt—are, year by year, vanishing; and we have met cordially on common ground to assist and encourage one another in the pursuit of objects honorable and serviceable to the whole family of man.

"While, however, this effect is produced, whether our meetings be in Oxford or in Cambridge, in Edinburgh or in Dublin, in Liverpool or in Cork—or again whether they be in England or in Genoa, in Milan or in Naples—let us not forget, that if we raise the standard of science in our own country, we raise the national character also, and its just influence in other countries; and that while individual benevolence is

promoted by personal intercourse in these re-unions, the benefit of the labors of every such association is national also. None can doubt that the reputation of our country depends far more on its intellectual strength than on its military glory. Without for a moment undervaluing those to whom in past ages as in the present, England is, humanly, indebted not merely for her empire but for preservation also, I cannot doubt that the European reputation of England is owing far more to Newton than to Marlborough. I believe that every new discovery of science which England is permitted to make, while it adds perhaps directly to her wealth or indirectly to the development of her resources, adds also to her influence in the scale of nations. Our government has exercised a prudent and sagacious liberality in adopting thus far the suggestions of this Association for the advancement of science; and it may be well assured that such suggestions, made cautiously and disinterestedly by this Association, will continue to advance the public interests as well as the mere incidental honor of the body from which they proceed, and which, from past experience, may justly claim the confidence of the state.

"The interest of our nation in science has kept pace with the encouragement given by public authority to the cultivation of science.

"Our national collection may now be compared, not ostentatiously, but thankfully, with those of other countries; remembering, also, that our collections are little more than half a century old.

"The ornithological, the conchological, the mammalian departments in the British Museum are equal, I believe, to those of any other capital: greatly owing to the talents and labor of the eminent head of that department, Mr. Gray, whom I see here. The fossil divisions, under the care of my zealous, laborious, and able friend, Mr. König, are perhaps superior—in some classes beyond comparison. Last year there was added to the palæontology of the museum the unique specimens of the Holitherium of Kaup, the Cephalaspis of Lyell, the Lepidote of Fitton; and the collection of osteology is, as it ought to be, the first in England. The number of visitors, which six years ago was 319,000, was last year above 700,000—and the collections of comparative anatomy in the Hunterian Museum are, as they ought to be, the first in the world.

"With these indications of the state of science and of the taste for science diffused in our own country—sometimes as the fruit of the labors of this Association, sometimes as collateral and incidental, and even distinct results, but all showing the progress of physical knowledge or the means of extending or familiarizing it amongst us—I might finish my Address.

"But I cannot conclude without congratulating the University and the Association alike on this assemblage.

"We can never forget that the earliest, and in every sense the first, of the scientific bodies of England, the Royal Society, derived, as we learn from Bishop Sprat, its original and contemporary historian, its foundation in this place. We can never forget that Bishop Wilkins, the predecessor of my honored friend the Vice-Chancellor of Oxford in the government of Wadham College, was the chief promoter of its designs; that Sir W. Petty, the Wrens, Seth Ward, and Wallis, were his associates; and that here, for fourteen years, our own great and

good Robert Boyle, preëminent amongst early observers, and ever eminent for Christian principle and devotion, cultivated natural science; and, without for a moment undervaluing the mighty names which do honor to Cambridge—which do more, which do honor to England and our common nature—we may claim in Oxford the distinction of having nourished and sent forth the men who first laid the basis of the greatest of the scientific associations of the world.

"Here, then, the British Association gladly accepts the welcome now tendered to it within this venerable University. It was cordially received fifteen years ago, when this chair was worthily occupied,—and far more appropriately than by me—by my very reverend friend Dr. Buckland. I hope and believe that the feeling of good-will and respect will be mutual, enduring, and cordial; that the University will see with pleasure the progress of the natural sciences, and of the observations which the British Association has eminently encouraged;—and that the members of our Association will look with kindness and respect at the venerable seats of ancient learning, whence have been diffused through the land for many centuries the benefits of a large and liberal education, and the blessings of Christian instruction; where it is the earnest and habitual endeavor of those who teach—may it be alike the desire of those who learn—to sanctify the acquirements of the mind by the graces of the Spirit.

"I feel that I have very inadequately discharged the duties of the station in which I have been placed. Wherever the failure is less apparent, I unfeignedly desire you to attribute such partial success to the aid which I have received from Dr. Robinson, Prof. Owen, Mr. Robert Brown, and Colonel Sabine; since nothing which is derived from them can be unworthy of your notice. Lest you should have forgotten my earlier mention of them, I repeat this statement; and add again, that it is enough for me to be allowed to call such men my friends. My own avocations in later years have withdrawn me, as I have said, from the active pursuits of science; yet it was necessary for me to attempt some review of its later progress. I will only add my firm belief, that every advance in our knowledge of the natural world will, if rightly directed by the spirit of true humility and with a prayer for God's blessing, advance us in our knowledge of Himself, and will prepare us to receive his revelation of his will with profounder reverence.

"The improvements of modern arts have greatly facilitated the progress of science. Here how have they brought together from distant regions men of other tongues and other families, but not of other minds!—men whom I name to honor them; the Prince of Canino, Van der Hoeven, Langberg, Ehrenberg, Leverrier, Struvé, and Gautier, united here in one common object. In the words of the Prophet Daniel, if they may be applied without irreverence, 'men travel to and fro, and knowledge is increased.'

"May that knowledge be guided aright—may every acquisition of it be sanctified—as the circle widens, may every eye be still directed to the centre of all truth—and may every science, whether cultivated in connexion with this great Association or in the elder establishments of this great University, willingly, gladly, and cheerfully, lay its tribute on the altar of God."

ART. XXI.—*Theory of Transit Corrections;* by ENOCH F. BURR.

AN accurate determination of the element of time is so essential to the purposes of astronomy, that whatever may serve to to simplify or illustrate the modes of obtaining it, may justly be deemed of importance.

In expounding the theory of the transit instrument, the reasoning necessarily partakes much of a metaphysical character. From this cause, combined with limited space, a specific object or the necessities of a popular exhibition, arise certain assumed principles and partial demonstrations in our ablest treatises on the subject. This fact gives occasion for a few supplementary reasonings on the principles of the transit corrections.

There are four prominent corrections to be made in the applications of the transit instrument. These are for errors of observation, inequality of the intervals between the wires, the time of passing over these intervals, error of collimation and deviation of the optical axis from the plane of the meridian. A few suggestions will be made with reference to these corrections in their order.

An observer is liable to error in estimating the instant at which a star transits the wire which indicates the plane of the meridian. To correct for this error, and reduce its probable amount, other wires are introduced into the focus of the instrument, and a mean taken of the times of the transits over them all; and the reduction is proportional to the number of wires introduced. Let e= error of one observation and $\frac{e'}{n}$= the mean of a number of observations. Then $\frac{e'}{n}$ is probably less than e. There is no probability that e is less than $\frac{e'}{n}$ when all the errors denoted by e' are of the same sign, and one expression in this case has no advantage over the other. But these errors probably have *not* all the same sign; but some are negative while others are positive, and thus tend to cancel each other. This constitutes an advantage of the latter expression and renders it probably less than the first.

The diminution of error by taking a mean, is probably in proportion to the number of observations. Let $\frac{e}{n}$= the mean error of a number of observations, and $\frac{e \pm e'}{n+1}$= the mean error when the number of observations is increased by unity. Then $\frac{e \pm e'}{n+1}$

is probably less than $\frac{e}{n}$. For if the numerator of the first expression is not probably greater than that of the second while its denominator is greater than the denominator of the other, then the first expression is probably the smallest. But there is no probability that the numerator of the first is greater than that of the second, since there is as much chance that e will be negative as positive.

As the probable reduction of the error of observation is in proportion to the number of wires, it becomes important to connect as many with the instrument as possible. All the advantage, however, of an additional wire to the transit, in the use of the common method of taking a mean, may be gained by adding the times at all the wires to the time at the middle wire and dividing by the number of wires increased by one. This method gives a result probably as accurate as that which would be given by the other with a new wire added to the instrument. Let $e=$ error at the middle wire and $e'=$ sum of errors at all the wires. Then according to the method just stated, $\frac{e \pm e'}{n+1}$ is the mean error: a result just the equivalent of that given by the common method with an additional wire, inasmuch as there is no probability that the error at an additional wire will be more favorable in respect to amount and sign to the diminution of the numerator of the fraction expressing the mean, than the error at the middle wire. Indeed, the error at the middle wire is probably less than at an extreme one.

When the intervals between the wires of the transit are unequal, a correction must be applied for this inequality. It is given by eminent authority, that this correction is most perfectly applied by reducing the time at each of the wires separately to the middle wire and then taking a mean, thus requiring as many separate reductions as there are wires less one. But this process is tedious, and may be avoided with advantage in the following manner. Find the place of the mean of the wires. The product of the equatorial distance of this from the middle wire into the secant of the declination, applied with its proper sign to the time of the transit over the mean of the wires, gives the time of the transit over the middle wire. The time of the passage over the mean is found by dividing the sum of the times of the transits by the number of wires, and found with as much probable accuracy as would be connected with the time over the middle wire, obtained in the usual manner, when the intervals are equal.

Let $\gamma=$ true time at the mean of the wires.

$d, d_1, d_2,$ etc. $=$ equatorial distances of the wires from the mean.

$e, e_1, e_2,$ etc. $=$ errors of observation at the wires.

$\delta=$ declination of the star.

Then the observed times for a transit with five wires will be

$$\begin{aligned}
&\gamma \pm d \;.\sec\delta \pm e\\
&\gamma \pm d_1.\sec\delta \pm e_1\\
&\gamma \pm d_2.\sec\delta \pm e_2\\
&\gamma \mp d_3.\sec\delta \pm e_3\\
&\gamma \mp d_4.\sec\delta \pm e_4
\end{aligned}$$

and their sum, $5\gamma \pm \mathrm{D}.\sec\delta \pm \mathrm{E} = 5\gamma \pm \mathrm{E}$ since $\mathrm{D}=0$.

Dividing by 5 we have $\gamma \pm \frac{\mathrm{E}}{5}$ (1).

Now it is evident that if γ is taken to represent the time of the transit over the *middle* wire, and the equatorial intervals be equal, the sum of the coefficients of sec δ is zero, and there is a liability to just as large an error of observation at each wire. Hence the time of transit at the middle wire would be found $\gamma \pm \frac{\mathrm{E}}{5}$ (2): a result no more accurate for the middle wire than was the previous one for the mean of the wires.

If to expression (1), the product of the equatorial distance of the mean of the wires from the middle wire be applied with the proper sign, γ, which represents the true time of passage over the mean of the wires, will become the true time of passage over the middle wire, and the expression (1) will become identical with expression (2): the same result will be obtained as if the equatorial intervals had all been equal.

The correction for the inequality of the intervals may also be made, by reducing the times of the transits on one side of the middle wire, to what they would have been, if each wire had been as far from the middle as is the one corresponding to it on the other side, and then using these reducing times in obtaining a mean.

Let γ = true time of passage at the middle wire d', d'', etc. = true times between the middle and other wires.

Then

$$\begin{aligned}
&\gamma \pm d' \quad \pm e\\
&\gamma \pm d'' \quad \pm e_1\\
&\gamma \qquad\quad \pm e_2\\
&\gamma \mp d''' \pm e_3\\
&\gamma \mp d'''' \pm e_4
\end{aligned}$$

will be the *observed* times of the transits. Now conceive a quantity $\pm b$ added to d'', such that $d'' \pm b = d'''$, and also another quantity $\pm b'$ added to d', such that $d' \pm b' = d''''$. In this case, when the quantities are added, the second column will disappear, and dividing by 5, we have $\gamma \pm \frac{\mathrm{E}}{5}$: as accurate a result as is obtained when the intervals between the wires are all equal; since the observer is liable to just the same errors at the wires.

It is well known that the time occupied by a star in passing over a given part of the field of view, is not accurately expressed by the product of its equatorial value into the secant of the declination. This arises from the inequality of the arcs of different diurnal circles, intercepted between the same limits. The formula which is strictly accurate, is, in its common form,

$$\gamma x = \frac{\text{arc} \cdot \sin (15 \cdot \gamma y \cdot \text{arc } 1'' \cdot \sec \delta)}{15}$$

Where $\gamma x =$ time of passage from one wire to another,
$\gamma y =$ equatorial interval between them.

But there is another known form, which, while it indicates the operations to be performed more clearly than the last, is sometimes otherwise more convenient for use. It may be thus demonstrated.

Let $x =$ arc of a diurnal circle intercepted between two wires.
$y =$ arc of equator intercepted between the same.
$x' =$ a part of x equal to y.

Then $\gamma x = \gamma y \cdot \sec \delta$.

$$\gamma x' : \gamma x :: x' : x$$

$$\gamma x = \frac{\gamma x' \cdot x}{x} = \frac{\gamma y \cdot \sec \delta \cdot x}{y}.$$

But $y = \sin x = \sin\left(\frac{180 \cdot x}{\pi \cdot \cos \delta}\right) \cdot \cos \delta = \sin (m \cdot x \cdot \sec \delta) \cdot \cos \delta$

And arc $(m \cdot x \cdot \sec \delta) = \sin (m \cdot x \cdot \sec \delta + \frac{\sin^3 \cdot (m \cdot x \cdot \sec \delta)}{2.3} + \text{etc.}$

$$= y \cdot \sec \delta + \frac{y^3 \cdot \sec^3 \delta}{2.3} + \text{etc.}$$

But arc $(m \cdot x \sec \delta) = x \cdot \sec \delta$

$$\therefore x = y + \frac{y^3 \cdot \sec^2 \delta}{2.3} + \text{etc.}$$

And $\gamma x = \gamma y \cdot \sec \delta \left(1 + \frac{y^2 \cdot \sec^2 \delta}{2.3}\right)$.

$$= \gamma y \cdot \sec \delta + 37 \cdot 5 \cdot \text{arc}^3\, 1'' \cdot \gamma y^3 \cdot \sec^3 \delta.$$

The two corrections of the time for error of collimation and deviation of the transit axis from the plane of the prime vertical, are given respectively by the expressions $c \cdot \sec \cdot \delta$ and $a \cdot \sin (\varphi - \delta) \cdot \sec \delta$; so that the equated error of the clock becomes $Æ - \gamma - a \cdot \sin (\varphi - \delta) \cdot \sec \delta - c \cdot \sec \delta$. In these expressions φ is the latitude of the place of observation, $Æ$ the right ascension of a star, and a, c, the deviation and error of collimation. It is plain that the values of a and c might be determined from any three equations of the error of the clock, but this method is much less accurate, on account of errors of observation, than another which is sometimes employed. This latter method may be ex-

emplified with reference to c, and consists in subtracting two equations, one of which is the sum of several such equations of the error of the clock as contain large coefficients of c, and the other the sum of an equal number of such equations as contain small coefficients of c, and such coefficients of a that their sum will nearly balance and cancel the other coefficients of a in the subtraction. Then the error of the clock disappears, the term into which a enters being very small, may be neglected, and c becomes known. The superior accuracy of this method, which we find assumed, it may be well to establish.

Before proceeding farther, however, it should be observed that while the expression for the effect of the error of collimation upon the time, needs in strictness of theory to be subjected to the same modification as that which commonly expresses the time of a star between two wires, the difference between the value of this expression and the true correction, is always practically inappreciable. The time occupied by a star in passing from a small circle of the sphere parallel to the meridian, to the meridian, is equal to the space passed over, expressed in time, into the secant of the declination; but this space or the arc of the diurnal circle intercepted between the two circles, is different for different declinations, and hence the constant c can only represent it approximately. In practice, however, the difference is of no consequence. Let $0''{\cdot}05$ be the greatest allowable error in the value of the correction arising from the use of the form $c \cdot \sec \delta$. Then at $88° 30'$, the declination of Polaris, the error of collimation must be 10^s; which is greater than it will ever be when any sort of care is used in making the adjustment.

The value of c as found by the common method, is much less affected by errors of observation than that found from any three equations. The effect of these errors on the value of c as determined by the common method, is expressed by the algebraic difference of two sets of errors into a coefficient which is a very small fraction, and which may be made of any degree of smallness, while the effect of the errors of observation on c as found by the other method, is expressed by two terms each of which is the algebraic difference of two single errors into a coefficient which is probably integral. Now, since there is no probability that the sum of these two errors is less than the greatest, if it can be shown that the coefficient of either is integral, and that there is no likelihood that its factor is any less than the corresponding factor of the term which expresses the effect of the errors of observation in the common method, it follows that this effect is probably much less than that incident to the other method.

Let $x = Æ - \gamma - a \cdot m - c \cdot n$
$x = Æ' - \gamma' - a \cdot m' - c \cdot n'$
$x = Æ'' - \gamma'' - a \cdot m'' - c \cdot n''$

be three equations of the error of the clock, the transit axis being assumed perfectly horizontal. Then if c is sought, the coefficient of one part of the effect of the errors of observation on its value is

$$\frac{1}{(n-n')-\frac{(n'-n'')\cdot(m-m')}{(m'-m'')}}.$$

But $n-n'$ is always a proper fraction in our latitude for instruments having only a southern exposure, and is in fact as far as the latitude whose tangent is $\sqrt{3}$. The same is true of $n'-n''$, $m-m'$, and $m'-m''$. But $\frac{n'-n''}{m'-m''}$ is also a fraction, since the numerator is a less fraction than the denominator.

For $m'-m''=\sin(\varphi-\delta')\cdot\sec\delta'-\sin(\varphi-\delta'')\cdot\sec\delta''$

$=\cos\varphi\,(\tan\delta'-\tan\delta'')$

$n-n''=\sec\delta'-\sec\delta''$.

Differentiating $\cos\varphi\cdot\tan\delta''$ we have $\cos\varphi\cdot\sec^2\delta''\cdot d\delta''$, and $\sec\delta''$ we have $\sin\delta''\cdot\sec^2\delta''\cdot d\delta''$.

Hence we have $\cos\varphi\cdot\sec^2\delta''\cdot d\delta''>\sin\delta''\cdot\sec^2\delta''\cdot d\delta''$ when $\delta''<90^\circ-\varphi$. From this we have

$$\cos\varphi\cdot(\tan\delta'-\tan\delta'')>(\sec\delta'-\sec\delta'').$$

The same is true when one of the declinations is negative, since observations will not be made near the horizon. Then $m'-m''>n'-n''$ when the greatest declination is less than the complement of the latitude of the place of observation. Hence it follows that the reciprocal of $(n-n')-\frac{n'-n''}{m'-m''}\cdot(m-m')$, which is the coefficient of one part of the effect of the errors of observation, is integral when the transit has only a south exposure.

If the instrument commands the whole meridian, we may show that the coefficient of one part of the effect of the errors of observation, cannot be largely fractional without making the coefficient of the other part integral. The denominators of the two coefficients are

$$(m-m')\left(\frac{n''-n'}{m''-m'}-\frac{n-n'}{m-m'}\right). \quad . \quad . \quad 1.$$

$$(m'-m'')\left(\frac{n''-n'}{m''-m'}-\frac{n-n'}{m-m'}\right). \quad . \quad . \quad 2.$$

If the first expression is largely integral, $m-m'$ must be so also, inasmuch as the compound factor can never exceed 2.6.

$$\frac{n''-n'}{m''-m'}=\frac{\sec\delta''-c'}{\tan\delta''\cdot\cos\varphi-c''}.$$

Differentiating and establishing the condition of a maximum, we find $\sec \delta'' - c' = (\tan \delta'' . \cos \varphi - c'') . \frac{\sin \delta''}{\cos \varphi}$. Substituting in the original expression, it reduces to $\frac{\sin \delta''}{\cos \varphi}$; the greatest possible value of which in our lat. is 1·33. Taking this twice we have 2·6. Making, then $m - m'$ very large in expression (2), let us ascertain its greatest value. It is evident that this expression is the greatest, other things being equal, when $\frac{m'' - m'}{n'' - n'}$ is the greatest, i. e. when δ'' is the greatest and δ' is the least. Taking $\delta'' = 88° 30' =$ declin. of Polaris and $\delta' = 0$, we find $\frac{n'' - n'}{m'' - m'} = -1·29$. Now the maximum value of expression (2) is when $\sin \delta'' = \frac{n'' - n'}{m'' - m'} . \cos \varphi = -, 97$ in the lat. of New Haven, i. e. when $\delta'' = 76° 56'$, and may be found by calculation to be 76. Hence it appears that if one of the two coefficients is a small fraction, the other must be integral.

The remaining point is evidently established, if we show that there is no likelihood that either set of errors is greater than the corresponding single error of the other expression. Each set of errors in the expression which gives the effect of the errors of observation in the common method, is the algebraic sum of a number of errors. Let us conceive two of these errors to be taken at hazard. Then there is no probability that their algebraic sum is greater than the greatest of them, inasmuch as there is no probability that both have the same sign. Now let another error be taken in the same manner. Then there is no probability that the sum of the *three* is greater than the sum of the two first, for the same reason as before: and, as there is no likelihood that the sum of the two is greater than the greatest of them, there is none that the sum of the *three* is greater than the greatest of the two errors taken at hazard. In the same manner we might go on adding single errors and reasoning reversely, and thus prove that there is no probability that the algebraic sum of any given number of errors is greater than the greatest of any two of them, taken at random. But now there is no probability that this greatest of the two is greater than the error corresponding to the set in the first factor of the second expression, and therefore none that the algebraic sum of all the errors constituting the set, is greater than this error.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On Ozone;* by M. Berzelius, (Berzelius's Jahresbericht, xxvi; Chem. Gazette, 109, p. 71.)—After detailing the results of Marignac's experiments in thirteen propositions, M. Berzelius goes on to say, "From these experiments Marignac has drawn the conclusion that ozone is most probably a peculiar modification of oxygen; but considering the circumstance that it is not produced by absolutely dry gases, he has left it undecided whether it may not perhaps contain some hydrogen.

"The last uncertainty, however, has been removed by an experiment of De la Rive. Chlorate of potash is fused to remove all moisture, and then a slow current of dry oxygen disengaged from it; this is passed through a glass tube of about one line internal diameter, into which two pieces of platinum wire have been fused, so that they are a small distance from and opposite to each other. Now when a current of electricity is conveyed to the earth through the wires of the conductor of an electrical machine in action, a succession of sparks results between the wires, and the oxygen is thereby converted into ozone, which is recognized by its powerful odor and its reactions, especially towards iodide of potassium and starch, which is most readily observed. As soon as the electric current ceases, unaltered oxygen again issues from the tube.

"We have thus arrived at the highly important result, that ozone is no peculiar element, and likewise that it is not an unknown combination of known elements, but that it is oxygen in a different allotropic condition, from the ordinary oxygen gas, as this is contained in the atmosphere or obtained in chemical experiments. Our knowledge of the dissimilar allotropic states of the elementary substances has thus obtained an unexpected and highly remarkable addition. In accordance with the other elements, we may represent it by the symbols $O\alpha$ and $O\beta$. $O\alpha$ is distinguished from $O\beta$ by its odor, and by the tendency it has to form combinations in circumstances under which the latter is perfectly inactive, similar to what likewise occurs with other elements. Whether these modifications are preserved in the combination or only one of these states, and which belongs to the oxygen in combination, are questions which still remain to be answered. We have seen that the electrical spark converts a certain quantity of $O\beta$ (probably corresponding to the capacity of the spark) into $O\alpha$, and this satisfactorily explains the electric odor. We have, moreover, learned that those bodies which become oxydized at low temperatures, for instance phosphorus, are likewise capable of producing a change, but that in this case the presence of another gas besides oxygen is absolutely requisite, as hydrogen, nitrogen, or carbonic acid; but whether these gases take an active part, or remain passive and merely dilute the oxygen, is not yet known. I may call to mind the effects of phosphorus upon oxygen by mere rarefaction under the air-pump, which have not yet been

satisfactorily explained. Is Oα likewise formed under these circumstances?

There still remains to examine the comprehensive field of extremely interesting comparisons between the different properties of these two allotropic modifications, a subject of inquiry of the greatest importance for science. We have already become acquainted with the mysterious statement of Leuch, according to whom Oα (galvanized air) can be used with considerable advantage for bleaching purposes, and indeed surpasses all other bleaching materials.*

2. *On the relations of Glycocoll and Alcargene;* by T. S. Hunt, (communicated for this Journal.)—The similarity which exists between the compounds of nitrogen and arsenic is such, that they are regarded as belonging to the same natural group and capable of replacing each other in combination. Kakodyle and its derivatives are as yet the only organic bodies known which contain arsenic; of these, M. Gerhardt has shown that alcarsine is to be regarded as an alkaloid in which arsenic takes the place of nitrogen, but the parallel substance containing nitrogen is as yet unknown; and hitherto we have been unable to complete the analogy between these elements, by the discovery of two corresponding compounds, the one containing nitrogen and the other arsenic.

The substance known as glycocoll, or gelatine-sugar, is shown by the recent researches of Horsford and Laurent,† to have the composition before suggested by Gerhardt and declared by Dessaignes from the results of the decomposition of hippuric acid. Its equivalent is represented by the formula $C_4H_5NO_4$. The alcargene or kakodylic acid of M. Bunsen is produced by the slow oxydation of kakodyle or alcarsine; one equivalent of alcarsine and eight of oxygen, yield two of alcargene and two of water.‡ $C_8H_{12}As_2O_2+8O=2C_4H_5AsO_4+2HO$.

The equivalent of this substance then is represented by $C_4H_5AsO_4$, which differs from the formula of glycocoll only in the substitution of As for N.

A notice of some of the characters of the two substances will serve to show their close affinity. Both glycocoll and alcargene are capable of exchanging one equivalent of their hydrogen for a metal; and in addition to this character in which they resemble acids, act the part of organic bases by combining directly with acids to form definite crystallizable compounds. Some of these corresponding combinations are here represented.

Glycocoll,	$C_4H_5NO_4$	Alcargene,	$C_4H_5AsO_4$
Argentic "	$C_4(H_4Ag)NO_4$	Argentic "	$C_4(H_4Ag)AsO_4$
Hydrochloric "	C_4H_5NO,HCl	Hydrochloric "	$C_4H_5AsO_4,HCl$

To these characters we may add that both glycocoll and alcargene are readily soluble in water, sparingly soluble in alcohol, crystallize with

* For a notice of the history and nature of ozone, see this Journal, vol. ii, ii Series, 103.

† This Journal, ii Series, vol. iii, pp. 267–258 and 369.

‡ See the corrected formula for this substance in M. Gerhardt's Précis de Chimie Organique, vol. ii, p. 445.

facility, and are not volatile without decomposition. They also resemble each other in having no deleterious action upon the animal system, a property that is very remarkable in a body which like alcargene contains more than 72 per cent. of arsenic. From these facts the conclusion seems unavoidable, that alcargene is the arsenical species of a genus of which glycocoll may be regarded as the type.

Glycocoll is isomeric with the hyponitrous ether of Liebig. This substance which is regarded by M. Gerhardt as the nitric species of acetene C_4H_6, is, like many other bodies of a similar constitution, decomposed by the action of sulphuretted hydrogen. When a current of this gas is passed into an alcoholic solution of the ether, previously mixed with a little solution of ammonia, it is rapidly absorbed, while the liquid assumes a dark orange-red color, and deposits a large amount of sulphur. In this process a volatile substance of a powerful alliaceous odor and pungent taste is formed, but the small quantity which I obtained in a single experiment, did not allow me to determine its nature. It may perhaps be a body corresponding to alcarsine, of the formula $C_8H_{12}N_2O_2$, or a sulphuretted species of it. Four equivalents of the ether, and eight of the sulphuretted hydrogen, would yield one equivalent of this compound with the separation of six equivalents of water and eight of sulphur; the tendency of the bodies of the acetic series to unite and double their equivalent, is well known. This however is merely a probable conjecture, and I shall take the earliest opportunity to determine its truth or falsity. The substance $C_8H_{12}N_2O_2$ should yield glycocoll by oxydizing agents.

It will be very important to examine the action of reducing agents and sulphuretted hydrogen upon glycocoll, as alcargene, by these means, affords alcarsine, and a species in which its oxygen is replaced by sulphur. I have commenced some researches upon these, the results of which I will send you as soon as they are completed.

Montreal, May 25th, 1847.

3. *Varrentrapp and Will's Method for the Determination of Nitrogen: An Improved Apparatus;* by Prof. E. N. Horsford, (communicated for this Journal.)—The excellence of the method of MM. Varrentrapp and Will, in the combustion of bodies whose per-centage of nitrogen is low, has secured its almost universal adoption.

Two objections have been made to it, and both of them by the gentlemen to whom we are indebted for the labor of removing the practical difficulties which necessarily surround this and every new process.

The first is in the determination of nitrogen in bodies, where nitric acid is present. The per-centage is uniformly too low. No plan has yet been suggested by which to surmount this difficulty.

The other is, generally, with bodies in which the proportion of nitrogen is large. It arises from the impossibility of perfectly controlling the current of evolved ammonia and other gaseous products. When from any cause the combustion proceeds for a moment slower than it should, or the first bulb of the apparatus becomes suddenly cooled, the hydrochloric acid retreats into this bulb, occasioning with the suddenly and greatly increased surface, as the acid issues from the neck, an instantaneous absorption of the ammonia—a partial vacuum and a consequent rush of the acid in jets into and across the bulb. Not unfrequently

the jet extends into the combustion tube sometimes cracking it, and otherwise, without this issue, causing the loss of the whole determination.

This catastrophe is especially to be feared toward the conclusion of the combustion, when little except pure ammonia occupies the interior of the tube. MM. Varrentrap and Will suggested the mixture of sugar or tartaric acid with the body to be analyzed, that other gases in quantity might be furnished and the ammonia thus diluted. The difficulty to some extent still remained, and gave rise to Schlossberger's apparatus.

Fig. 1.—Varrentrapp and Will's Apparatus.

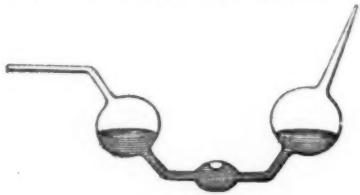
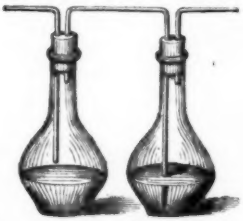


Fig. 2.—Schlossberger's Apparatus.



It consisted of two little flasks, of the size used in alkalimetry by Fresenius and Will, connected by tube and corks, and so disposed as to admit air from without, in the event of condensation, without the possibility of the acid ascending into the combustion tube. This improvement most effectually removed all liability to danger.

It had however two objections:—*complication* and *cork surfaces*. It is composed of seven pieces, while the apparatus of MM. Varrentrap and Will consists of but one.

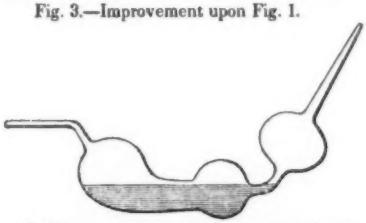
To unite the safety of the former with the simplicity of the latter, was a great desideratum.

An examination of the conditions of the problem, renders its solution easy.

The starting back of the acid follows an absorption more rapid than the evolution. The fluid that had been driven forward into the second and third bulbs, slowly returns toward the first. As the acid enters the bulb nearest the combustion tubes, the sudden expansion of its surface occasions such rapid absorption that a partial vacuum is produced. The liquid comes in so fast, that with the rush of air and vapor into the condensation tube, some of the acid is carried with it.

The causes of the difficulty are the too rapid increase of absorbing surface, and the smallness of the bulb. These are removed in the

Fig. 3.—Improvement upon Fig. 1.



slight modification of the apparatus represented in fig. 3. Its use has realized all the expectations entertained. It is entirely safe.

Cambridge Laboratory, May, 1847.

4. *On a quick Method of determining the quantity of Nitrogen in Organic Substances;* by Eug. Peligot, (Comptes Rendus, March, 1847.)—The method of Varrentrapp and Will was considered a great improvement in the determination of nitrogen, particularly on account of the saving of time, &c. But this process although requiring only a short combustion, needs a prolonged manipulation of the platinum salt, and is liable to several species of error.

The method of Peligot is a simple alteration of that of Varrentrapp and Will. The combustion is performed in the same manner, but the ammonia is condensed by a known quantity (by volume or weight) of sulphuric acid. After the combustion, this acid is transferred to a cylindrical vessel, the washings added, and the strength of the acid determined by the volumetric method. The difference between this and the original strength gives the quantity of acid saturated by the ammonia, and consequently the ammonia.

For this last determination, the author prefers the solution of caustic lime in syrup. This solution preserved in close vessels undergoes no change, and even after absorbing carbonic acid from the air, it needs only a filtration to fit it for use. The strength of the alkaline solution must be previously ascertained by the usual methods.

The results are accurate—an analysis of oxamide gave 31·3 per cent. nitrogen, theory requiring 31·7. By this method a determination of nitrogen may be made in less than half an hour, with an accuracy at least equal to that obtained by the usual methods which require never less than three hours.

M. Peligot considers this method peculiarly useful in the case of physiological investigations, as the determinations, being useless unless comparative and therefore numerous, may be multiplied almost without trouble or expense. G. C. Schaeffer.

5. *Preparation of Sulphocyanid of Ammonium;* by J. Liebig, (Liebig's Annalen, Jan., 1847.)—A small quantity of sulphuret of ammonium in the presence of excess of sulphur produces the unlimited conversion of cyanid of ammonium into sulpho-cyanid—hence the following process: 2 oz. sol. caustic ammonia, sp. gr. 0·95, are saturated into sulphuretted hydrogen, and then mixed with 6 oz. of the same solution of ammonia; 2 oz. flowers of sulphur are next added, and then the product of the distillation of 6 oz. prussiate of potash, 3 oz. sulphuric acid and 18 oz. water. The mixture is digested in the water bath until the sulphur is no longer acted upon and the liquid becomes yellow; it is then boiled till the sulphuret of ammonia is driven off and the liquid has again become colorless. The excess of sulphur being removed, the liquid yields on evaporation over 3 oz. pure white sulphocyanid, which may be used as a reagent instead of the sulphocyanid of potassium.

This reaction of prussic acid with the higher sulphurets of ammonium affords a very good test for the acid, as the sulphocyanides and persalts of iron are more delicate tests for each other than the component cyanides and iron salts forming prussian and other blues. G. C. S.

6. *On the Decomposition of Nitrite of Ammonia;* by E. Millon, (Ann. de Chem. et de Phys., Feb., 1847.)—Heat decomposes the solution of nitrite of ammonia, water being formed and nitrogen given off; but if a drop of caustic ammonia is added to some of the solution in a

thin glass tube, it may be boiled for hours without decomposition. Acids produce the contrary effect, causing the immediate destruction of the nitrite.

The author proposes the following easy process for nitrate of ammonia. An excess of caustic ammonia in a platinum crucible is placed in a cooling mixture. Into this is to be passed very gradually the nitrous vapor, from the dry distillation of nitrate of lead. The solution must be evaporated in an atmosphere of ammoniacal gas, over lime.

The decomposition by sulphur, has been previously noticed by Pelouze. G. C. S.

7. *On a new Mode of estimating the Nitrates, and particularly Nitre;* by J. PELOUZE, (Comptes Rendus, Feb., 1847.)—The solubility of all the nitrates preventing any application of the usual methods, and yet the large quantity of nitre consumed annually in the manufacture of gunpowder requiring some mode of determination approaching accuracy, many ingenious processes have been devised, and of these a very complete history is given in the first part of the paper.

A method has been recently proposed by M. Gossart, which consists in mixing the salt with sulphuric acid and decomposing it by a normal solution of protosulphate of iron—the completion of this action being determined by ferridcyanid of potassium, for when this indicates the presence of protoxyd of iron, it is known that all the nitre has been consumed. The quantity of solution used, gives by a simple calculation the quantity of nitric acid or nitre.

M. Pelouze considers the process as original with M. Gossart, and happy in its invention. Certain difficulties however, have led to improvements by Pelouze, which seem to give the method a high degree of accuracy. He first determined the quantity of pure nitrate of potash requisite to peroxydize a known weight of pure iron, (piano wire being selected as the purest and most convenient.) 2 grms. of wire dissolved in an excess of hydrochloric acid, on an average required 1·216 grms. of nitrate. This decomposition involves 6 equivs. iron and 1 equiv. nitrate, the acid being decomposed into deutoxyd of nitrogen, which is given off, and into oxygen, which produces the perchlorination of the iron. Thus:

$$6FeCl. + NO_5KO + 4HCl = 4HO + KCl + NO_2 + 3(FeCl_3).$$

(This reaction is proposed as an excellent method of preparing the deutoxyd of nitrogen.) As the presence of chlorids and sulphates in the crude nitre does not interfere, it is only necessary to operate upon 2 grms. iron and 1·216 of nitre, and by a standard solution of chameleon mineral (permanganate of potash), ascertain how much iron remains to be peroxydized. The method of preparing and using this last solution will be found in this Journal for September, 1846, p. 257.

In an actual analysis, 2 grms. of wire are placed in a suitable flask with 80 to 100 grms. strong hydrochloric acid; the flask is closed by a cork having a fine tube in it. After dissolving the iron with a gentle heat, 1·216 grms. of the nitre to be examined, are added, the flask closed and the whole boiled. As soon as the gas has escaped, and the brown color disappears, the liquid becomes clear and yellow—after boiling five or six minutes it is poured into a quart flask, the wash water added and water to fill the vessel. The normal solution of permanganate is then applied until after agitation a faint rosey hue remains.

In the first part of the process the continual escape of vapor and gas prevents the entrance of the oxygen of the air—after this there is no further danger, as iron in a strongly acid solution is peroxidized with much difficulty, even by exposure to the air.

In general it is best to use the nitrate in a solid form—but to prevent variations in small samples of crude nitre, it is best to dissolve a large quantity and take the proper proportion of the solution for analysis. Of course this process only indicates the quantity of nitrate and does not show the adulteration of nitre by nitrate of soda. G. C. S.

8. *On the Composition of Quinoidine;* by J. LIEBIG, (Liebig's Annalen.)—Quinoidine has been considered by some chemists as a mixture of quinine and cinchonine with resin, which prevents crystallization. Others regard it as a distinct alkaloid. Liebig however found it to yield on distillation as much quinoleine as pure quinine, and on analysis it proved to have the same composition and atomic weight. Quinoidine is therefore nothing more than amorphous quinine. G. C. S.

9. *On the Fat Acids of the Oil of Ben;* by P. WALTER, (Comptes Rendus, June, 1846.)—The oil of ben is the produce of the *Moringa aptera*, and was formerly much used in perfumery as a vehicle for odors, being in itself perfectly scentless. Walter found on examination no volatile acid, but stearic, margaric, and two new fat acids. The one, *Benic* acid, is very small in quantity, its formula $C_{30}H_{30}O_4$ standing between nysistic and ethalic acids. Melting point about 127°. Benic ether is a readily fusible solid.

The other acid is named from the plant, *Moringic* acid—its formula $C_{30}H_{23}O_4$. This is a colorless or yellowish oil, solidifying at 32°, soluble in alcohol, and decomposed by sulphuric acid when heated with it. G. C. S.

10. *On the Fermentation of Tartaric Acid;* by I. NICKLÈS, (Comptes Rendus, Aug., 1846.)—Noeldner described as a peculiar acid that which results from the fermentation of tartrate of lime containing impurities. Berzelius pronounced this acid, called the pseudo-acetic by Noeldner, to be a mixture of acetic and butyric acids.

M. Nicklès does not decide upon this point, but states that an acid is formed containing the elements of acetic and butyric acids, having the composition $C_6H_5O_4$. This would be isomeric with Gottlieb's metacetonic acid.

The experiments given by the author are not quite conclusive as to the separate existence of this acid. G. C. S.

11. *On the Preparation of Ferridcyanid of Potassium;* by A. and C. WALTER, (Buchn. Rep., xliv, p. 42; Chem. Gaz., June 1, 1847.)—Yellow prussiate of potash is boiled with 12 to 15 parts of water, and while boiling, good chlorid of lime added until a filtered sample appears red, or no longer yields a blue precipitate with persalts of iron. It is then quickly filtered, a little carbonate of potash added to the solution until it has a faintly alkaline reaction, and then evaporated to crystallization; the crystals obtained are purified by recrystallization.

12. *On the Method of separating Cobalt from Manganese, proposed by Barreswil;* by A. STRECKER, (Liebig's Annalen, Feb., 1847; Chem. Gaz., May 15, 1847.)—A short time since M. Barreswil* proposed a

* See this Journal, vol. ii, ii Series, p. 260.

very simple method of separating these two metals, by adding carbonate of baryta to the solution containing them, and then passing sulphuretted hydrogen into it. The author, before employing it, wished to ascertain whether in reality no manganese would be precipitated, as stated by M. Barreswil, and mixed for this purpose solutions of the protochlorid and of the protosulphate of manganese with pure carbonate of baryta, and passed sulphuretted hydrogen into them. It was found that nearly the whole of the manganese was precipitated, and the filtered alkaline liquid became turbid on heating to boiling, and contained now not a trace of manganese. This is readily explained by the behavior of carbonate of baryta towards sulphuretted hydrogen. When a current of this gas is passed into water containing carbonate of baryta in suspension, a portion of it is decomposed in the same way as the alkaline carbonates, and the liquid contains a considerable quantity of baryta in solution, partly in the form of carbonate dissolved in carbonic acid, partly as hydrosulphuret of barium and hyposulphite of baryta. The very alkaline liquid is rendered turbid by boiling, with separation of carbonate of baryta, and on evaporation to half its volume constantly disengages sulphuretted hydrogen; upon the addition of muriatic acid, this gas and carbonic acid escape, and the liquid is rendered turbid by sulphur; sulphuric acid indicates the presence of a large amount of barytic salts. It is to be hoped that when M. Barreswil next imagines a method, he will test its correctness before publishing it.

13. *Occurrence of Arsenic in Vinegar*, (Journ. de Chim. Méd., ii, p. 334; Chem. Gaz., June 1, 1847, p. 213.)—M. Deschamps found, on preparing pure acetic acid from wood-vinegar, that the latter contained arsenic, which he ascribes to arseniferous sulphuric acid having been used in the manufacture of the pyroligneous acid. As wine-vinegar is frequently strengthened with pyroligneous acid, M. Chevalier was induced to examine several samples of ordinary vinegar, and found some of them to contain very perceptible quantities of arsenic.

14. *Mode of detecting the Adulteration of Olive Oil with Rape or Poppy Oil;* by M. Diesel, (Archiv. de Pharm. in Chem. Gaz.)—Common nitric acid colors pure olive oil green; a mixture of olive and rape oil produces a yellowish grey color, and with poppy oil a yellowish white. After about twelve hours, pure olive oil is itself colored; the determination must therefore be made before that time has elapsed.

G. C. S.

15. *On a Ready Method of determining the Amount of Nicotine in Tobacco;* by M. Schloesing, (Comptes Rendus, Dec., 1846.)—Ten grammes of tobacco are to be exhausted with ammoniacal ether, in an apparatus for continued distillation, the ammonia expelled by boiling, the solution decanted and the ether evaporated. The amount of nicotine is then determined by sulphuric acid of known strength, according to the usual alkalimetric method.

This process was found to give results closely agreeing with the amount determined by a careful separation of nicotine.

Tobacco containing a large per cent. of nicotine seems to be that generally preferred for the manufacture of snuff. The snuff itself contains but about one-third of this nicotine, the remainder having been destroyed by the fermentation. This increases the quantity of ammo-

nia, which together with the nicotine and their salts, give the snuff the power of exciting the mucous membrane of the nose.

The following per-centages of nicotine in several French and American tobaccos, were determined by the above mentioned method.

Lot, - -	7·96	per cent.	of nicotine	in the dry tobacco.
Lot Garrone, -	7·34	"	"	"
Nord, - -	6·58	"	"	"
Ile et Vilaine, -	6·29	"	"	"
Pas de Calais, -	4·94	"	"	"
Alsatia, - -	3·21	"	"	"
Virginia, -	6·87	"	"	"
Kentucky, -	6·09	"	"	"
Maryland, -	2·29	"	"	"
Havana, less than	2·00	"	"	"

G. C. S.

16. *On the influence of Ammonia upon the Nutrition of Animals;* by Fred. Kuhlmann, (Comptes Rendus, Feb., 1847.)—While engaged in the researches of which we have already made mention, M. Kuhlmann was led to doubt the commonly received opinion that ammonia is injurious to animal life. He had observed the growth of large numbers of freshwater shells in a ditch which received the washings of animal black at his establishment. This water was found to hold in solution bicarbonate of ammonia and carbonate of lime. Insects too are often produced in vast numbers amid ammonia exhalations. In order to test the direct effects of this substance, the author determined to try the experiment of mixing ammonia with the food, and the carbonate was chosen as being less modified in its effects than any other salt, by the action of its acid.

Two pigs of nearly equal weight were fed with the same kind and quantity of food, with this exception, that one took 100 grammes of carbonate of ammonia in solution, each day. This diet was continued for two months, during which time the health of the animal receiving this singular treatment seemed not in the least affected. Repeated weighings showed no very great difference in their increase, and at the end of the two months, the animal fed in the usual manner had gained 3½ kilogrammes on 78, while the other had gained 1 kil. on 76, although the latter had consumed more than 6 kil. (over 13 pounds) of carbonate of ammonia.

The most curious effect of this diet was upon the urine; that from both animals was acid when fresh, but after fermentation the urine from the ammoniacal diet contained one-fifth more of carbonate of ammonia than the other—showing the presence of an increased quantity of urea. The author suggests that other changes in the digestion must have attended the transformation of the carbonate into urea, and proposes a further investigation of the subject.

The experiment is certainly curious, and deserves repetition under a variety of conditions; but we cannot deny that the results are susceptible of quite a different interpretation from that given by the author. G. C. S.

17. *On several Detonating Compounds formed by the action of Nitric Acid upon Sugar, Dextrine, Lactine, Mannite and Glycerine;* by ASCAGNE SOBRERO, (Comptes Rendus, Feb., 1847.)—Several of these compounds have been found by the author and MM. Flores Domonté and Ménard, simultaneously. The sugar compound on analysis, showed a replacement of 2 equiv. hydrogen. The glycerine compound requires care in its formation, or oxydation takes place. When the mingled nitric and sulphuric acids are kept in a freezing mixture and the glycerine is added slowly, with stirring, it dissolves entirely with no visible reaction. The addition of water precipitates a heavy oily looking liquid, which may be washed in water, dissolved in alcohol and separated by the addition of water. It resembles light yellow olive oil, is heavier than water, in which it is quite insoluble—it dissolves freely in alcohol and ether, is without smell, and of a sweetish pungent and aromatic flavor. It must be tasted with great caution, as a quantity sufficient to moisten the end of the finger, when applied to the tongue produces the most unpleasant effects of nausea and headache, which last for several hours. No analysis of this compound has been made. G. C. S.

18. *On the Exhalation of Bicarbonate of Ammonia by the Lungs;* by LEWIS THOMPSON, (Phil. Mag., Feb., 1847.)—The moisture exhaled from the lungs, on examination was found to contain bicarbonate of ammonia—the quantity for each individual rather more than three grains per day. To prove the presence of ammonia in the breath, the author directs us to breathe for an hour or two, air which has passed through dilute sulphuric acid. The exhalation is condensed by passing through a tube cooled to 32°. The fluid collected is to be acidulated with a drop or two of pure muriatic acid, and evaporated to dryness. Treatment of the residue by potash, produces the usual reactions of ammonia. G. C. S.

19. *Analysis of a Concretion from a Horse's Stomach, performed by Mr. Charles M. Wetherill and Dr. Boyé,* (Proc. Amer. Phil. Soc., iv, p. 330, Jan., 1846.)—This concretion, for a fuller description of which, in connection with its history, Dr. B. referred to his friend, Dr. B. H. Coates, by whom it was handed to him for examination, is remarkable for its size, weighing $11\frac{3}{4}$ lbs. It is of an oval shape, smooth surface, brownish-grey color, and breaks in concentric layers of different degrees of thickness, exhibiting a fibrous or radiated structure. The outer layer alone was analyzed. The concretion was found by Dr. Coates, to contain a nail in its centre.

By a qualitative examination, it was found to consist of phosphoric acid, magnesia, ammonia, chemically combined water, a small portion of organic matter, and silex. It contained no lime. In order to determine quantitatively these ingredients, a portion was dissolved in dilute hydrochloric acid; the insoluble residue collected on a counterpoised filter, dried and weighed; after incineration and weighing, it yielded *insoluble inorganic matter* 0·45 *per cent.*, which, deducted from its former weight, gives *insoluble organic matter* 0·64 *per cent.*

To the filtered solution was added a weighed portion of iron wire, dissolved in nitro-muriatic acid, and the whole then precipitated by ammonia. Having previously ascertained the amount of peroxyd of iron yielded by an equal portion of the same iron wire, the difference

in weight of these two precipitates gave for the *phosphoric acid* 32·40 *per cent.*

To the filtered solution from the phosphoric acid, was added caustic potash in excess, and the whole boiled until the ammoniacal vapors were effectually expelled, and the solution gave a strong alkaline reaction. The magnesia thus obtained was collected upon a filter, washed with boiling water, incinerated and weighed; it yielded *magnesia* 14·45 *per cent.*

Another portion of the powdered concretion dried over sulphuric acid in vacuo at ordinary temperatures, yielded *hygrometric moisture*, 1 *per cent.*; incinerated, it yielded *volatile matter* (*water and ammonia*), 51·70 *per cent.*

In order to ascertain the amount of ammonia, another portion of the powder was introduced into a small tubulated retort, with carbonate of soda and water. The neck of the retort was adapted to a small tubulated receiver containing dilute hydrochloric acid, and having adapted to its tubulure a nitrogen bulb, such as is used in ultimate organic analysis; this also contained dilute hydrochloric acid. The mixture in the retort was evaporated to dryness; and at the close of the operation, air was drawn through the apparatus to insure the absorption of the last portion of ammonia. The *ammonia* thus obtained was estimated by precipitation by chlorid of platinum, as in organic analysis, and yielded 0·71 per cent.

Hence the composition of the concretion is as follows:—phosphoric acid 32·40 per cent., magnesia 14·45, water 50·35, ammonia ·71, insoluble inorganic matter ·45, insoluble organic matter ·64, hygroscopic moisture 1·00=100·00.

It will be seen from this, that the ammonia is too small to be considered an essential ingredient of the concretion. Assuming it to exist in the state of double phosphate of ammonia and magnesia with water ($NH^4O, 2MgO, PO^5+2HO+10HO$), and deducting the amount of this salt from the rest, (omitting the insoluble matter and hygroscopic moisture,) it will be seen that the concretion is composed mainly of the phosphate of magnesia and water, according to the following formula, $3MgO+3HO+2PO^5+24$ aqua, as will be seen from the following comparison:—

By Experiment.			By Calculation.	
Phos. acid,	33·56		$2PO^5$,	33·70
Magnesia,	14·55		$3MgO$,	15·20
Water,	51·89		24Aq.	51·10
	100 00			100·00

20. *Acetate of Lime formed in Coal Pits*, (Proc. Amer. Phil. Soc., Jan., 1846, iv, p. 239.)—Dr. Boyé stated that by a visit to Colemanville Iron Works, Lancaster County, Pa., he had found on the outer surface of the coal pits for charring wood, a yellowish white deposition.

On examining this deposition, it was found to consist of acetate of lime. By dissolving it in water and treating it with animal charcoal, the acetate of lime was obtained perfectly colorless. Dr. Boyé remarked, that the lime was probably derived from the soil, but as acetate of lime was not volatile, it must be carried up mechanically by the vapors

of pyroligneous acid and other volatile substances, given off by the process of charring.

21. *Reducing Copper Ores by Electricity*, (London Mining Journal.)—Having published several communications on this subject, inquiring the nature of the process, and also descriptive particulars from our respected correspondent, Mr. John Mitchell, of Napier's patent, we now give the general particulars of the French invention, mentioned by "J. H." of Cornhill—that of MM. Dechaud and Gualtier de Claubry. These gentlemen have long been engaged on the effect of weak electrical currents on copper ores; and the following is an account of the results at which they had arrived before taking out their patent. The process consists of two operations—viz: roasting the ore, and the precipation of the copper. The roasting is effected in a reverberatory furnace, either by the conversion of the sulphuret into sulphate by the action of the air; or in the transformation of the oxyd of copper into sulphate, by calcining it with sulphate of iron, at a dull red heat in a current of air—the iron being left in a state of peroxyd. Washing, then, extracts the sulphate of copper—so that the most impure minerals will afford copper equally pure with the carbonates or oxyds. In the precipitation by galvanism, batteries would be far too costly; and they have obtained the same results without the use of exterior batteries. The principle is as follows:—If two solutions are placed one over the other, one of sulphate of copper very dense, and the other sulphate of iron less dense, and in the first is placed a plate of copper, and in the second a fragment of cast iron, and then these two metals are united by a conductor, the precipitation of copper commences at once, and is completed in a long or short period, according to the temperature, the concentration of the liquids, and the extent of metallic surfaces—the state of the copper becomes greatly changed as the liquor becomes weaker. To obviate this, they take advantage of the following phenomena: After some minutes' action, there exist four strata in the liquids; at the bottom is a dense solution of sulphate of copper, then a less dense solution of the same salt; next, a sulphate of iron, and on the surface a less dense solution of the same. If, therefore, we arrange at the level of each of these liquids, suitable apertures for the addition or removal of the liquid, they can be kept at a uniform state of density, and thus the copper is always pure, and in the same physical condition.

For convenience, the liquids are now arranged in vertical, instead of horizontal, layers; they are then to be separated by a diaphragm very permeable to electricity, but not to liquids—pasteboard answers perfectly well for this, and lasts for months. The apparatus is then arranged as follows: A chest of wood, lined with lead or some suitable mastic, contains the solution of sulphate of iron; into this chest a number of cases are plunged, made of a frame having its ends and bottoms formed of iron plates coated with lead, the sides being of pasteboard. The strong solution of sulphate of copper enters through a pipe near the bottom, and escapes in its weak state through an opening at the top; in each case is placed a sheet of leaded iron, and between each are plates of cast-iron; separate rods connect each plate with the common conductor, which is supported over the apparatus, and the copper is precipitated on both sides of the sheets of metal, the pasteboard preventing the imme-

diate contact of the two liquids; the sulphate of iron thus floats above the sulphate of copper, and the apparatus fulfils all that is required. At a temperature of 68° Fah., 10·73 feet of surface will receive 15·444 grs. of copper in 24 hours, perfectly pure, and immediately fit for hammering or passing through the rolling-mill. This manufacture of copper presents no difficulties, requires no refining, and gives no scoria. The patentees consider that as a metallurgical result 50 per cent. of the copper is obtained in sheets; 25 per cent. in fragments, which require fusion; and 25 per cent. of powder requiring subsequent refining. The application of galvanism to smelting appears to be reduced to the simplest form, and electrotypes on the largest scale can be obtained.

II. Mineralogy and Geology.

1. *M. Nordenskiöld upon Diphanite, a new Mineral Species from the Emerald Mines of the Ural in the neighborhood of Catherinenburg*, (translated from Poggendorff's Annalen, Vol. 70, p. 554, and communicated for this Journal, by W. C. Lettsom.)—His excellency the minister of the interior, M. Porowsky was so good as to transmit to me for examination a specimen of considerable size from the well known Emerald mines of the Ural, upon which in addition to a white mineral resembling mica, there were several blueish, transparent prismatic crystals, very similar in their appearance to apatite.

Upon closer examination it turned out that these two substances, different as they are in appearance, are one and the same mineral, and one that both by its superior hardness and by the difference of its behavior before the blowpipe, is quite distinct from either of those substances.

The mineral in question, as I shall presently show, is one of the order of hydrous double silicates and I propose for it the name Diphanite, from δις and φανις, with reference to its presenting in different directions a totally different appearance.

Diphanite occurs in regular six-sided prisms with a remarkably distinct foliated cleavage at right angles to its principal axis, and belongs therefore to the rhombohedral crystalline system. No other terminal planes than those due to the foliated fracture were noticed.

The prisms when viewed sideways are of a blueish color, they have a vitreous lustre and are transparent; but when viewed perpendicular to the cleavage, the mineral appears white with a pearly lustre, and is no longer transparent unless indeed it is a very thin film that is under examination. Its hardness ranges from 5 to 5·5 at most, upon a perfect cleavage-plane it is somewhat less. It is exceedingly brittle. Surfaces due to mere fracture were not observed in consequence of its great facility of cleavage. Its specific gravity varies from 3·04 to 3·07.

Its behavior before the blowpipe is as follows. In the closed tube it assumes a deeper color, giving off an empyreumatic odor with a deposition of moisture, which upon turmeric paper gives no indication of the pressure of fluorine. Alone, it becomes opaque, swells up and becomes scaly, and in the inner flame fuses to an enamel without bubbles. With bisulphate of potash it does not tinge the flame red. With borax it fuses readily to a transparent glass, which upon cooling par-

takes somewhat of a yellowish tinge. Salt of phosphorus dissolves it readily, with a residue of silica, to a clear glass, which upon cooling becomes yellower than might be expected from the white color of the mineral. With a little soda it gives a bubbly glass, dark colored externally; upon the addition of more soda it gives an infusible enamel somewhat colored by manganese.

Lieut. Colonel von Jewreinoff has analyzed this substance with great care and accuracy. The most complete analysis of three, all agreeing however closely, gave the following results.

		Oxygen.		Oxygen.	
Silica,	34·02			17·66	(15)
Alumina,	43·33			20·23	(18)
Lime,	13·11	3·66	(16)	4·57	(4)
Protoxyd of iron,	3·02	0·68	(3)		
Protoxyd of manganese,	1·05	0·23	(1)		
Water,	5·34			4·73	(4)
	99·87				

Hence we deduce for the composition of this mineral,

$$2\dot{C}a^2\ddot{S}i+3\ddot{A}l^2\ddot{S}i+4\dot{H},$$

the Ċa representing or comprising the compound equivalent

$$\dot{M}n+3\dot{F}e+16\dot{C}a.$$

In accordance with this formula, the result of the analysis would be

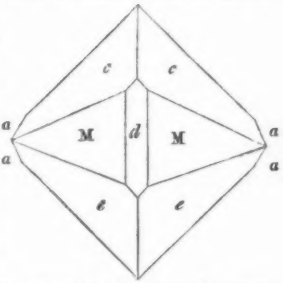
Silica,	33·21
Alumina,	44·33
Lime,	13·11
Protoxyd of iron,	3·04
Protoxyd of manganese,	1·13
Water,	5·18
	100·00

2. *Mineralogical Notices;* by Charles Upham Shepard, M.D. (Communicated for this Journal.)

Tautolite on the north shore of Lake Superior.—This singular, trappean obsidian was presented to me by Mr. Thomas R. Dutton, on his return from a tour of mining explorations on the north shore of Lake Superior. He informed me that it occurs in veins from one to six inches wide, traversing a stratified greenstone or amygdaloid, situated upon Simpson's Island, as well as upon Fluor Island, which is two miles west of St. Ignas. The mineral has a velvet-black color, a subconchoidal fracture, and a shining vitreous lustre. Its Hardness = 6·5 . . . 7·0. Gravity = 3·86. It breaks with the greatest facility, being more brittle than obsidian. Before the blowpipe it fuses into a black glass, attracted by the magnet.

It forms in its color and tenacity a striking contrast with the dysclasite, a mineral found on the south side of the lake in connexion with the trap and the copper, in large sized masses of a pure snow white, or pale rose color, specimens of which were two years ago presented to me by Prof. Forrest Shepherd.

Farther account of the Arkansite.—Mr. W. S. Clark, a student in Amherst College, having recently furnished me with a good sized specimen of this mineral,* in which it presents itself in very beautiful crystals as well as massive, (the whole resembling a mass of Elba specular iron ore,) I am able to add a few particulars to my first account of the species.† The crystals differ considerably in the relative size or development of the planes, from the modification first described, and besides in presenting the new faces *a*, which result from the truncation of the acute angles of the primary form. The planes M are here better adapted to measurement than in the first specimens examined, though still obliging us to employ the reflexions of a lamp light in place of the ordinary window bar. The value obtained for M was constantly between 101° and 101° 15′, and that for *a* on *a*, 123°.



In my first account, I accidentally omitted to give the specific gravity. It is 3·854. This result I have confirmed by fresh trials.

The chemical examination has been so far extended by the present supply of material, as to establish the conclusion that the before discovered titanic acid in it is possessed of those traits which have induced Prof. Rose to distinguish it as an acid of a new metal, called by him Niobium.

In a perfectly powdered state, the mineral is decomposed by four hours boiling in concentrated sulphuric acid, its color gradually changing during the digestion from dark ash grey to a pale yellowish white. It was transferred to a Berlin porcelain crucible and ignited. After full ignition for ten minutes, it was removed from the fire, when it was observed that it still emitted fumes of sulphuric acid. On a farther heating however, these fumes ceased to be evolved. It was found to have lost only 1·89 p. c. of its original weight, and to possess a yellow color while hot, which faded out to white on cooling.

A. It was now treated with dilute sulphuric acid and boiled for half an hour; after which the liquid was poured off, and the insoluble matter was again thoroughly heated and weighed. It had lost scarcely more than 1 p. c. by the process. The acid liquid gave with ammonia a slight flocculent precipitate.

B. A portion of the insoluble powder A was fused with three parts of carbonate of soda for half an hour. It melted perfectly, and had on cooling, a faint bluish tinge in spots. Water loosened it from the crucible, but dissolved it only in the slightest portions. On dropping into this solution either hydrochloric or sulphuric acid, a white precipitate was produced, which did not disappear by boiling. The liquid gave with alcoholic solution of nutgalls, a rich red brown or orange precipitate.

* Mr. Clark received his specimen from Dr. Hitchcock, to whom it had been sent by Dr. W. B. Powell, of the Medical College of Memphis, Tenn. Rev. Mr. Beadle, of New Orleans, from whom I obtained my first specimens of Arkansite, informs me that he received them from Dr. Powell, who was the original discoverer of the locality at Magnet Cove.

† This Journal, ii Ser., vol. ii, p. 250.

C. The insoluble matter B (which the water would not dissolve) was rapidly taken up by hydrochloric, as well as by sulphuric acid, and on boiling became troubled. In these solutions also, the nutgalls produced a rich, orange red precipitate.

D. A portion of the powder A was fused with hydrate of potassa in a silver crucible. Water dissolved the mass freely, compared with the fused mass B. On filtering, the solution soon became turbid, (and on standing a few days, a most abundant white precipitate had subsided.) Portions of the liquid gave with either of the acids above mentioned, a copious white precipitate which did not dissolve by boiling. The acid liquors gave with nutgalls, rich orange red precipitates, and with ferrocyanid of potassium a red brown precipitate, which was somewhat diminished by the addition of hydrochloric acid.

E. A somewhat bulky precipitate was left after the affusion of boiling water upon the mass obtained by fusing the powder with potassa. This readily disappeared on being treated with sulphuric acid, though on boiling it became turbid. It was filtered, and subsequently precipitated by a boiling saturated solution of sulphate of potassa. On cooling, the liquor became heavily clouded with a white precipitate, which on boiling cleared up, but returned as it cooled. The white precipitate was separated by a filter, and across this, boiling water was poured, which dissolved out nearly all its contents. From this solution, potassa threw down a bulky precipitate which dissolved in sulphuric acid, which solution was turbid when boiled, and cleared up, to a certain extent, in cooling.

F. The clear sulphate of potassa, solution E, was also precipitated by potassa. The precipitate was ignited, after which it freely dissolved in sulphuric acid, and the solution remained clear on boiling.

My conclusion from the foregoing is, that the Arkansite is a Niobate of yttria and thorina?

Native Platinum in North Carolina.—In November last, I received in a letter from Hon. T. J. Clingman, of Asheville, N. C., a small reniform grain of native platinum, with the following remark.—"The enclosed metallic grain was given me by a friend, who says it was found among the gold of one of his rockers. It looks like native platinum." Its weight was 2·541 grs. There was no difficulty, by means of its physical and chemical properties, in identifying it with the substance above suggested. Its specific gravity = 18. In a subsequent letter dated Jan. 3d, (written before receiving my reply,) Mr. C. adds still farther, "Mr. T. T. Erwin, who presented it to me, says that his overseer, in whose veracity he has the fullest confidence, gave it to him with the gold obtained from the rocker. and that he (Mr. Erwin) does not entertain the smallest doubt of its having been found in his mine in the north part of Rutherford Co. Should it prove to be platinum, it is a matter of interest to me, as the first specimen of that mineral found in the United States."

Fearing however that the grain might have originated in a foreign locality, I addressed particular inquiries to Mr. C. on this head, and received from him the following additional statements.—"The platinum specimen formerly sent you, was taken from the gold rocker by Mr. Lyon, the overseer of Mr. Erwin. Mr. L. is a man of good character, and all persons who know him entertain no doubt whatever of his hav-

ing obtained the specimen as represented. Mr. L. had no suspicion of its being any thing more than silver, which was known to be found with the gold. The place at which he obtained it, was in Rutherford Co., near the line of the new county of McDowell. I would have sent you his certificate, but I had no doubt that other specimens would be found. In fact, almost every miner to whom I described it said, he had seen just such specimens, but they had supposed them to be fragments of steel or iron that had been broken from the edges of the mining tools."*

3. *Oxyd of Cobalt with the Brown Hematite Ore of Chester Ridge, Pa.*, (Proc. Amer. Phil. Soc., Jan., 1846, iv, 239.)—Dr. Boyé exhibited to the Society a specimen of brown hematite ore from Chester Ridge, three-fourths of a mile west of Chester furnace, Huntingdon County, Pa., containing a small quantity of *oxyd of cobalt*,—the surface of the ore is in some places covered with a thin film of oxyd of cobalt. It also contains a moderate proportion of manganese.

The ore was dissolved in chlorohydric acid, the solution neutralized by ammonia, and then the iron precipitated by boiling after previous dilution with water. The oxyd of cobalt which remained in the solution with the manganese, was discovered both by its reaction in the moist way, and by the blue bead it yielded with salt of phosphorus.

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* *Bismuthic Gold.*—In the letter from which the above is extracted, was forwarded to me a few grains, of which the largest weighed only 0·907 gr., of an alloy of bismuth and gold, to which faint traces of mercury were adhering. Concerning their origin, Mr. C. observes, "They were brought to me by a friend, Mr. Willis, under the impression that they might be platinum. They were mixed with the gold of several days work, and I assisted him in picking them out from a parcel that he brought to the bank in this place. They are evidently not grains of platinum."

In structure they are hackly, or sub-fibrous. Hardness = 2·5 ... 3·0. Gr. = 12·44 ... 12·9. Color that of palladium. Malleable, but when thinned out under the hammer it becomes brittle. Scarcely acted upon by nitric acid, or by hydrochloric alone; but in the two, slowly dissolves save traces of a heavy white precipitate. Heated before the blowpipe on charcoal, it melts as soon as touched by the flame into a globule which gives off a white smoke, at the same time coloring the support of a bright yellow, while the charcoal remains hot, but turning white, when cold. If allowed to cool, the globule crystallizes beautifully, with a coarsely indented surface, and has its color changed from grayish white to a distinct golden yellow tinge. By continuing the heat, the globule gradually wastes away to less than half its original bulk, crystallizes less distinctly, grows less fusible, and finally it puts on the appearance of pure gold.

The foregoing notice is introduced here in the form of a note, on account of the suspicion entertained that the substance may prove to be only a product of the miner's process of separating his gold by means of amalgamation, instead of being a true mineral production. Dr. Gibbon, the Superintendent of the U. S. Branch Mint at Charlotte, N. C., whose opinion on the subject I solicited, assures me, that bismuth has repeatedly been detected in several of the gold districts of the southern states, and that he thinks the substance in question is probably a natural production. Mr. Clingman also observes in reference to the same point, "It is my opinion that the grains sent to you were in their natural state. I have seen gold coated so as to be blackened by a film of lead supposed to be obtained from the mercury, but it was only superficial and could easily be rubbed off; but the grains sent you were of a steel grey color, and when fractured were seen to have the same color within as externally. Some of them indeed had a color more nearly inclining to yellowish, and yielded slightly before breaking."

4. *Note by M. D'Orbigny on the Orbitolina*, (mentioned by Mr. Lyell, at p. 186, this volume.)

Paris, 18th June, 1847.

To C. Lyell, Esq.

Dear Sir,—I have been long acquainted with the fossil body, which you forwarded to me, and at this moment I am printing in an elementary work, all the mistakes concerning it; it is, in fact, of all genera that perhaps which has been most often misunderstood, and I should call it the greatest culprit in geology. It is a genus nearly allied to *Orbitolina*, and which I have named, in consequence of this analogy, *Orbitoides*. It has always been taken for a nummulite, though it differs from it by the most marked characters. I have known many species such as the *O. media*, *papyracea*, and that which you have forwarded to me, and which I had designated by the name of *Americana*. The *Orbitoides* are found in the cretaceous and tertiary formations, the Nummulina in the tertiary only. Such at least is the result of my numerous investigations on this subject. The species that you have forwarded to me, had been sent me from North America with a great number of tertiary and cretaceous shells; it came to me without any information respecting it, and I am anxious to know where you found it.

Yours, &c. Alcide D'Orbigny.

5. *Observations on the Drift Furrows, Grooves, Scratches, and Polished Surfaces of the Rocks of Lake Superior;* by Forrest Shepherd, (in a letter to Prof. Silliman.)—I have noticed, both on the northern and southern shores of Lake Superior, innumerable longitudinal furrows, grooves, scratches and also smoothly polished surfaces, upon granite, sienite and greenstone. These grooves run generally in a direction north and south, varying occasionally with slight obliquity. When the surface of the lake is quiet, these marks may be seen at a considerable depth beneath the transparent water corresponding with those seen on the same rocks at the present level of the lake. You may thence ascend upwards on the banks and hills, on the islands and shores of the lake, and by removing the moss and vegetation, you will find these marks continue with remarkable uniformity until you reach the summits of the Huron Mountains, which according to the measurement of Capt. Bayfield, are situated eight hundred feet above the present level of the lake. While standing on the summit of these mountains, in some places I found the compact undecomposed feldspar, as smoothly polished as if it had been soft wood recently subjected to the carpenter's plane or drawing knife; while in other places were to be seen marks and furrows as above mentioned. These appearances, which I have described, are all upon rocks in place, and could not, I think, have resulted from natural structure. Nor could they have resulted from causes now in operation on the shores of this great body of fresh water; for there is no perceptible difference between the marks on the same kind of rock at the present level of the lake, and those at a greater height or lower depth. By enumerating the concentric circles of the largest trees (Pinus abies) which are now standing on the shores of the lake, only three or four feet above the surf, and comparing them with the decayed trunks of similar ones whose stumps have been preserved by having been charred by the fire passing over them, it is perfectly

evident that the present level of the lake has not varied materially during the last six or seven hundred years. Such trees may be seen on Portage Lake, Point Keeweenon, and also near the old trading post on the north shore, north of Montreal River. Such a lapse of time or even half its duration, would certainly enable present agencies to render the above marks particularly conspicuous at the present water level. But such does not appear to be the fact.

I would here remark that the main body of the lake never freezes, and that ice only forms along the shore and in the bays. Nor are there any appreciable tides or currents in this lake except those produced by winds, and the unequal pressure of the atmosphere. There are, however, a great many water worn and furrowed boulders with longitudinal marks and scratches, at different heights all along from the summits down to the level of the lake. Among them I have noticed large blocks and boulders of conglomerate lodged on the summit of greenstone ridges high above the conglomerate in situ, showing evidently that the drifting current moved from the north to the south. There are also vast beds of diluvium filled with such boulders, and particularly on the northern shore eastward of the Les Petits Ecrits, repeated terraced banks for miles in length, maintaining a horizontal line with all the regularity of the present shore. These terraces ascend like steps to the height of three or four hundred feet at least whilst receding about two or three miles. There can be no reasonable doubt that the waters have at different successive periods prevailed at these several different heights. The present level of the lake is reported to be six hundred and twenty seven feet above the tide of Hudson's Bay. I presume the drift furrows will be found on all the prominent rocks between these two bodies of water. So far as I had opportunity to examine, I invariably discovered them on the mountains intermediate.

III. Zoology.

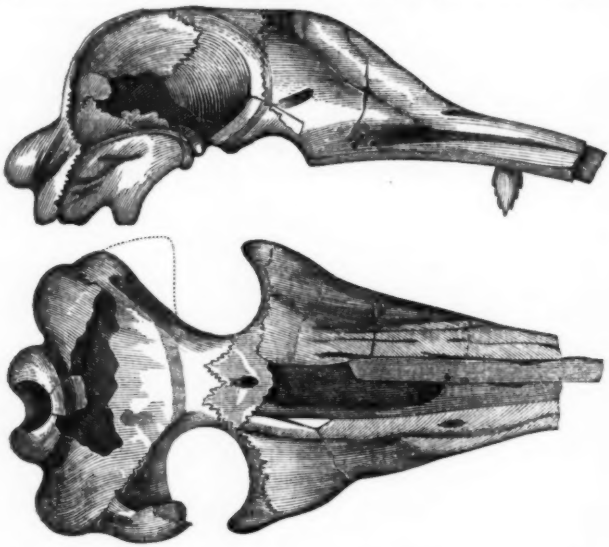
1. *Discovery of the Cranium of the Zeuglodon;* by M. Tuomey, State Geologist of South Carolina, (Proc. Acad. Nat. Sci., iii, p. 152, Feb., 1847.)—Early in January I was presented by F. S. Holmes, Esq., with a portion of the left upper maxilla, containing one tooth and the alveolæ of several others, which he discovered in the Eocene beds of Ashley river, about ten miles from Charleston. Soon after, Prof. Lewis R. Gibbes, of the College of Charleston, visited the same locality, and had the good fortune to find the rest of the skull, much fractured, but so carefully were the fragments collected, that with a little patience we were enabled to restore them to their proper places. It is then altogether to these gentlemen that we owe the knowledge of this valuable fossil.

Description.—Occipital bone somewhat semicircular, transversely flat or slightly concave, central portion thin; a crest-like ridge surrounds the superior portion terminating in the suture with the temporal bone. Condyles two, articulating surfaces lunate, and almost enclosing the foramen magnum. Foramen magnum oval; transverse diameter 1½ inches, vertical diameter 1 inch; transverse processes thick, spreading, making the breadth of the base of the cranium equal to its diame-

ter across the zygomatic processes; jugular foramen $\frac{1}{2}$ inch in diameter; temporal bones small, mastoid portion thick and strong but not prominent; articulating cavities for condyles of lower maxillæ large, forming about 30° of a circle, inclining inwards and backwards; maxillæ thick and strong, vertical section triangular; a cavity for nerves and vessels runs within at the points of the roots of the teeth; alveolar process thick; palatal bone strong, anteriorly emarginate and horizontal, posteriorly descending below the alveolar process.

Frontal bone and anterior portion of maxillæ wanting; walls of the nasal canal smooth; sutures squamous; in the left maxilla one tooth remains, which is solid, spear-shaped, edges coarsely serrate, exterior side flattened, interior side convex; agreeing in this respect with the position of the teeth in the shark; roots double, nearly parallel, and inserted obliquely backwards; in the right maxilla are the alveolæ for eight teeth with double roots. In the solidity of the teeth and slight divergency of the roots, this specimen agrees with the figures of Dr. Harlan and Prof. Emmons.

This fossil is particularly interesting, as it removes every doubt, if any remain, of the true character of the animal to which it belonged. The double occipital condyle shows it to have been a mammal, while the squamous sutures and a symmetrical form refer it to the Cetacea.



Dimensions.—Length 14½ in.; greatest breadth 7½ in.; height 5½ in.; length of enameled portion of tooth $\frac{7}{8}$ in.; breadth $\frac{5}{8}$ in. It was evidently a young individual.

Geological position.—The teeth described by Dr. Gibbes were found in the oldest of the calcareous beds of the eocene of South Carolina, which contain *Cardita planicosta* and other well-known eocene fossils,

together with *Gryphea mutabilis* and *Terebratula Harlani*, which are also common to the cretaceous formation. And the fossil just described was found in upper beds of the eocene; so that the zeuglodon must have existed through the whole of the eocene period; a period which, in South Carolina, was at least sufficiently long for the deposition of three hundred feet of calcareous and sedimentary matter; a fact which was ascertained by boring at Charleston.

2. *The Beaver in Alabama;* by Prof. R. T. BRUMLEY, (from a letter to the editors dated University of Alabama, May 26, 1847.)—DeKay was certainly wrong, as Mr. C. B. Buckley states, in assigning the northern part of New York as the southern limit of the beaver.

Animals of this species are not uncommon in Alabama. They have been seen, recently, in several places; and, in 1838, they were discovered to be constructing a dam, &c. on Mr. Foster's plantation, ten miles south of Tuscaloosa, and west of the river. At that place, they cut down, in one night, a small tree ten inches in diameter, the stump of which, containing beautifully distinct impressions of their teeth, is now in the cabinet of this institution. They have not been disturbed, and may still be found there, though very wild.

There is, in the zoological collection of this institution, a well preserved skin of one, which was obtained in Alabama by Mr. McMillan, in 1831, while he was in the service of the University.

Beaver dams are still visible in several parts of South Carolina, where the animal was often seen in the early history of that state, and where, I believe, it still exists.

3. *Description of a new rapacious Bird in the Museum of the Academy of Natural Sciences of Philadelphia;* by JOHN CASSIN, (Proc. Acad. Nat. Sci. Philad., iii, 199, April, 1847.)—*Cymindis Wilsonii*, Nobis. ♂. Body above entirely dark brown, palest on the head, beneath white; every feather from chin to under tail coverts crossed by several bars of bright rufous chesnut, and these colors extending upwards into a collar around the neck; fourth, fifth and sixth primaries longest and nearly equal, external webs nearly black, internal webs of outer primaries white at base and for nearly half their length, the remaining part reddish inclining to chesnut, every primary (on its inner web) having two irregularly shaped black marks and tipped with black. Tail of the same color as the back but paler, white at base, and crossed by about four broad bars which are nearly black, the second bar from the tip accompanied by a narrow rather indistinct bar of rufous; tip of tail narrowly edged with white. Bill very large, (larger than in any other species of this genus,) yellowish white, inclining to blueish horn color at base.

♀. Body above entirely slate color, palest on the head, beneath barred with the same, the bars having a ferruginous tinge.

Total length of mounted specimen, from tip of bill to end of tail, 17 inches.

Hab. Island of Cuba.

The two specimens here described, were presented to the Academy by its esteemed member, Richard C. Taylor, Esq.

The bill in this species is very large in proportion to the size of the bird, and it agrees, moreover, tolerably well with the *written* descrip-

tion of Falco magnirostris, Gmelin,—so does the young Cymindis uncinatus, Illig. All authors, however, except Dr. Latham, clearly understand the F. magnirostris to be the bird figured in Enl. 464, which is a common South American species of the genus Astur.

Dr. Latham, in his article on F. magnirostris, Gen. His., vol. I, p. 282, gives a description of a bird suspected by him to be the species intended by Gmelin, which applies very well to Cymindis cayanensis, Gm., in young plumage, but not to C. Wilsonii.

I have named this species in honor of Dr. Thomas B. Wilson, as a slight tribute to his merits as a man, and his munificence as a patron of zoological science.

4. *Chamæa, new genus of Birds allied to Parus;* by Wm. Gambel, (from an article on the Birds observed in Upper California, Proc. Acad. Nat. Sci. Philad., iii, 154, Feb., 1847.)—Bill short, tapering to the point, acute and compressed. Both mandibles entire, ridge of upper elevated, and curving nearly from the base; the depression for the nostrils large, oval and exposed; the nostrils opening beneath a membrane in the depression. Wings very short and much rounded. Tail very long and graduated. Tarsus long.

Chamæa fasciata, Nobis. Ground Tit.

Parus fasciatus, Nobis, Proceed. Acad. Nat. Sci., vol. ii, p. 265.

This interesting bird, placed provisionally among the Titmice, I have now made the type of a new genus, not being able as yet, to find a suitable place for it, among those already described.

For several months before discovering the bird, I chased among the fields of dead mustard stalks, the weedy margins of streams, low thickets and bushy places, a continued, loud, crepitant, grating scold, which I took for that of some species of wren, but at last found to proceed from this wren-tit, if it might so be called. It is always difficult to be seen, and keeps in such places as I have described, close to the ground; eluding pursuit, by diving into the thickest bunches of weeds and tall grass, or tangling bushes, uttering its grating wren-like note whenever an approach is made towards it.

But if quietly watched, it may be seen, when searching for insects, to mount the twigs and dried stalks of grass sideways, jerking its long tail, and keeping it erect like a wren, which, with its short wings, in such a position it so much resembles. At the same time uttering a very slow, monotonous, singing, chickadee note, like *pee pee pee pee peep;* at other times its notes are varied, and a slow whistling, continued *pwit, pwit, pwit, pwit, pwit, pwit*, may be heard. Again, in pleasant weather towards spring, I have heard them answering one another, sitting upon a low twig, and singing in a less solemn strain, not unlike a sparrow, a lively *pit, pit, pit, tr r r r r r r r*, but if disturbed, at once resuming their grating scold.

IV. Astronomy.

1. *New Planet.*—On the first day of July, 1847, at $10^h\ 30^m$ P. M., Mr. Hencke, (the discoverer of the planet *Astræa*,) residing at Driesen, in East Prussia, discovered a star of about the ninth magnitude, not marked on the Berlin Star Chart. Its place was $257°\ 6'\ 7''$ R. A.,

and S. Dec. 3° 42′ 5″. On the 3d July, at 11^h 45^m, its place was 256° 40′ R. A. and 3° 51′ 5″ S. Decl. The new star was now in all probability, a planet hitherto unknown. At Berlin, July 5, 1847, at 10^h 48^m 28^s, M. Encke found its place to be 256° 51′ 34″·5, S. Dec. 4° 8′ 27″·8.

The new planet was observed in London, by Mr. J. R. Hind, July 10th, and at Philadelphia, at the High School Observatory, by Mr. S. C. Walker, on the 4th August. In a notice in the N. Am. and U. S. Gazette, Prof. E. O. Kendall communicates the following elements of the new planet, computed by Mr. Hind, from Encke's observation of July 5, and his own of July 10 and 14, showing that the body belongs to the group between Mars and Jupiter.

Epoch, 1847, July 0.	283°	56′	54″	
Perihelion,	8	17	24·1	} m. eqx. July 1.
Ascending node,	137	25	35·1	}
Inclination,	15	2	56·1	
Angle of eccentricity,	13	49	20	
Mean distance,	2·5216			
Sidereal period,	4·004 years.			

2. *Neptune, its supposed Ring and Satellite.*—Several European astronomers have pronounced in favor of the existence of a ring around the planet Neptune. Mr. Lassell, of Liverpool, observing with his Newtonian reflector, of two-feet aperture, first announced its existence, in October, 1846; and in January last, Prof. Challis, of Cambridge, using the large Northumberland reflector, was disposed to believe Mr. L.'s assertion. The ratio of the diameter of the ring to that of the planet is about that of 3 to 2. The angle made by the axis of the ring with a parallel of declination, in S. preceding or N. following quarter, is about 65°. Other observers, however, with equal means, cannot detect any such ring.

Mr. Lassell has announced to the London *Times*, his verification of the existence of a satellite of Neptune, suspected last November.

3. *New Comet.*—A telescopic comet was discovered by Mr. G. P. Bond, at the Harvard Observatory, July 14th, 1847. Its place, July 14th, 11^h 45^m, was 16^h 24^m R. A., N. decl. 85° 17′. Seen through the grand refractor, it exhibited a highly condensed central light, surrounded by a diffused nebulous appearance, with a faint tail stretching off in a direction opposite to the sun.

The same comet had previously been discovered by Mr. Mauvais, of Paris, July 4, 1847, its place being at 13^h 36^m 56^s, R. A. 22^h 8^m 13^s, and N. decl. 80° 26′.

4. *Vesta*, (from a letter from Prof. Mädler to Lieut. Gilliss, dated Dorpat Observatory, May 25; communicated for this Journal.)—"Vesta being very near to the earth in April and May, I undertook to measure its diameter, and obtained five sets of observations, which give sixty-six miles (fifteen to a degree). I have reduced the measured angles, by correcting them for 0″·3 irradiation, the angle of a fixed star given by the Dorpat refractor."

V. Miscellaneous Intelligence.

1. *Fall of Meteoric Stones in Iowa;* by Charles Upham Shepard, M.D., Prof. of Chem. in the Med. Coll. of S. Car., and in Amherst College, Mass., (communicated for this Journal.)—The present notice is only for the purpose of announcing a few particulars respecting this last fall of stones in the United States: fuller details of the occurrence, together with a description of the meteorite, will be reserved for a future occasion. The facts here presented are derived from the Rev. Reuben Gaylord, of Hartford, Des Moines County, Iowa, who visited the locality at my request, and has collected for me whatever specimens could be procured, by far the greater part having been broken to small fragments, and lost as it is feared to the purposes of science. The fragments forwarded to me by mail, and which are referred to in the following letter, leave no doubt of the genuineness of the production described. They consist of little globules of nickeliferous iron dispersed through the greyish feldspathic mineral, so common in meteoric stones. The fall took place in Linn County, and is well described in the following letter of Mr. Gaylord.

"Prof. C. U. Shepard:—I proceed now to give you the results of my investigation of the facts in relation to the meteor which fell in our state, in respect to which you wrote me some time since. Having learned particulars so far that I had full reason to credit the reports in the case, I repaired to the spot last week, and found the facts to be as follows. On the 25th day of Feb. 1847, at about ten minutes before 3 o'clock in the afternoon, the attention of the people in that region was arrested by a rumbling noise as of distant thunder; then three reports were heard one after another in quick succession, like the blasting of rocks or the firing of a heavy cannon half of a mile distant. These were succeeded by several fainter reports, like the firing of small arms in platoons. Then there was a whizzing sound heard in different directions, as of bullets passing through the air. Two men were standing together where they were at work; they followed with their eye the direction of one of these sounds, and they saw about seventy rods from them the snow fly. They went to the spot. A stone had fallen upon the snow, had bounded twice, the first time as was supposed about eight feet, and the second time about two feet. The stone weighed two pounds and ten ounces. The same persons heard another stone strike as it fell, supposed to be small, but they could not find it. Some time in the spring, another stone was found about one mile and a quarter west from the place where this fell. It was in two pieces lying together, weighing forty-six pounds. Another fragment, a portion of the same rock, was found about half a mile from the former, which from the description I had of it, I judged would weigh about fifty pounds. These were coated with a thin black covering. The principal ingredient in their composition seems to be sandstone. They are full of minute brilliant particles, and occasionally a small lump of some metal is to be found. Enclosed in this sheet I send you three or four small ones. Some were taken out as large nearly as a grain of corn. A man from whom I obtained a fragment insisted that they were silver. He had ground up a considerable portion of the rock to obtain this silver, and he thought he

had saved enough to make fifty cents (half a dollar). The above stones are all that have been found, as far as I could learn. The atmosphere at the time of this phenomenon was mostly clear, somewhat hazy, so warm as to cause the snow on the ground to be somewhat soft. The noise was heard distinctly to a distance of fifteen or twenty miles in every direction. At a distance of ten miles in each direction the sound was like the rolling of a heavy waggon passing swiftly over frozen ground. Smoke was seen in the direction from which the sound seemed to proceed. The smoke appeared in two places, apparently about six or eight feet apart, above the elevation of light clouds, and having a circular motion. The motion of the meteoric body was supposed from the reports which were heard, to be towards the southeast, or rather south of east."

Hartford, July 12th, 1847.

2. *Gutta Percha*, (Lond. Jour. Bot., No. lxi, Jan., 1847, p 33.)—This is a vegetable substance, which though only known to Europeans for a few years, is now extensively used in the arts for various purposes, as a substitute for caoutchouc, because it has the valuable property of dissolving without being volcanized. But while thus frequently employed, and constituting an important article of commerce, the plant which produces it was unknown, until, by a lucky accident, during the residence of Mr. Thos. Lobb in Singapore, where he has been (and in other Malay islands) employed in a botanical mission by Mr. Veitch of Exeter, he detected this plant and sent home numerous specimens, which prove it to be a new sapotaceous plant, of which a figure and description will shortly appear in this Journal, under the name of *Bassia?* Hook. Accompanying numerous well dried specimens, (though unfortunately without corollas,) Mr. Lobb judiciously sent small sections of the wood, which is peculiarly soft, fibrous and spongy, pale-colored, and traversed by longitudinal receptacles or reservoirs, filled with the gum, forming ebony-black lines.

It appears that a gentleman, Dr. Montgomerie, was the person who first brought the *Gutta Percha* into public notice. He writes thus, in the Magazine of Science, 1845, "I may not claim the actual DISCOVERY of *Gutta Percha*, for though quite unknown to Europeans, a few inhabitants of certain parts of the Malayan forests were acquainted with it. Many, however, of their neighbors, residing in the adjacent native villages, had never heard of it; and the use to which it was applied was very trifling, for I could only ascertain that it was occasionally employed to make handles for *parangs*, (or wood-choppers,) instead of wood or buffalo horn. So long ago as 1822, when I was assistant-surgeon at Singapore, I was told of *Gutta Percha*, in connexion with caoutchouc; and some very fine specimens were brought to me. There are three varieties of this substance, *Gutta Girek*, *Gutta Tuban*, and *Gutta Percha*. I may here mention that the latter name is often erroneously pronounced in England. The *ch* is sounded by the Malayans like those letters in our word *perch* (a fish). And attention to this point is of some importance; for if our countrymen were to ask the natives for *Gutta Perca*, they would probably be told, that such a substance was unknown, while plenty of *Gutta Percha* might be procured by pronouncing the word correctly. The name is pure Malayan; *Gutta*

meaning the gum, or concrete juice of the plant, and *Percha* (pronounced Pertcha) the particular tree from which it is obtained. I could not help thinking that the tree itself must exist in Sumatra, and perhaps derive its name from thence, the Malayan name for Sumatra being *Pulo Percha;* but though the Straits of Malacca are situated only one degree to the north of Singapore, I could not find that the substance has ever been heard of there or in Sumatra.

"But to return to the period when I first noticed the *Parang* handle that was made of *Gutta Percha*;—my curiosity being excited by the novelty of the material, I questioned the workman, a Malay woodsman, in whose possession I saw it, and heard that the material of which it was framed could be moulded into any other form, by dipping it into boiling water till it was heated through, when it became plastic as clay, regaining when cold its original hardness and rigidity."

Dr. Montgomerie goes on to say that he purchased the *Parang* handle and sent for more of the substance, and that on instituting experiments, he ascertained that *Gutta Percha* was likely to prove a most valuable material for making those parts of surgical instruments which had hitherto been formed of caoutchouc, the latter having the inconvenience of being easily injured by damp and hot weather in the tropics. The Medical Board of Calcutta highly approved of Dr. M.'s suggestion, and the Society of Arts in London awarded him its gold medal for the discovery.

Illness prevented Dr. M. at that period from visiting the forests where the tree grows. He, however, ascertained from the natives that the *Percha* is one of their largest trees, attaining a diameter of three or four feet, that its wood is of no value as timber, but that a concrete and edible oil, used by the natives with their food, is obtainable from the fruit. In many parts of the island of Singapore and in the forests of Johore, at the extremity of the Malayan peninsula, the tree is found: it was also said to grow at Coti, on the south-eastern coast of Borneo, and Dr. Montgomerie accordingly addressed his enquiries to the celebrated Mr. Brooke, resident at Sarawak, and was assured by that gentleman that it inhabits commonly the woods there also, and is called *Niato* by the people, who are not, however, acquainted with the properties of the sap. The tree is often six feet in diameter at Sarawak, and is believed by Mr. Brooke to be plentiful all over Borneo, and probably on the thousand islands that cluster to the south of the Straits of Singapore. Its frequency is proved by the circumstance that several hundred tons of the *Gutta Percha* have been annually exported from Singapore since 1842, when the substance first came into notice. There is reason, however, to fear that the supply must shortly decrease, and the price be raised, from the wasteful mode in which the natives collect it, often sacrificing a noble tree, of probably from 50 to 100 years growth, for the sake of 20 or 30 lbs. of gum, which is the largest quantity any one trunk ever affords. The juice might, in all likelihood, be obtained from the *Percha*, as from other trees, by tapping, and thus procuring a smaller portion for several successive years; but this process is too slow for the Malayans, and is also the less likely to be adopted because the forests are common property. The people fell the tree, strip off its bark and collect its milky juice in a trough formed of the hollow stem of the plantain leaf, when being exposed to the air, it soon coagulates.

Dr. Montgomerie suggests, among the less immediately obvious uses to which *Gutta Percha* is applicable, that of making raised type for the blind, and embossed maps for the same unfortunate beings: it takes a clear, sharp impression, and is also tough and durable: he thinks it would likewise be found serviceable in stopping decayed teeth.

In the abstract of the new patents, given in the October number of the *Magazine of Science and the Arts*, we notice that C. Hancock, Esq., has taken out a patent for improving the manufacture of *Gutta Percha*. He suggests several methods of purifying the substance, which generally comes home much mixed with extraneous matter:—it may be dissolved by heat and strained; or passed through a screw press; or melted by the addition of rectified oil of turpentine, and after filtering through flannel or felt the solvent may be evaporated. In every case, the *Gutta Percha* should form a residuum, of the consistency of dough or putty, this plastic state being gained by the maintenance of a suitable temperature during the above process.

Mr. Hancock would combine *Gutta Percha* with *Caoutchouc*, and a substance called *Jintawan*, (we have no clue to what this "jintawan" may be,) in order to form an elastic material, impervious to water; varying the proportions according to the greater or less degree of hardness or elasticity required. For making elastic bands, a compound is used, where 50 parts of *Gutta Percha* are combined with 24 of "jintawan," 20 of caoutchouc, and 6 of orpiment or sulphuret. From a mixture of these, Mr. Hancock also prepares a light porous and spongy material, suited for stuffing or forming the seats of chairs, cushions, matrasses, saddles, &c.; likewise, springs of clocks, clasps, belts, garters and string. Wherever the requisite is flexibility and elasticity, then the quantity of *Gutta Percha* should be diminished:—and increased where firmness is wanted. By prolonging the process, much hardness may be acquired, and moulds and balls of *Gutta Percha* will bear turning in the lathe, like wood or ivory. The material is also applicable to useful and ornamental purposes, as picture frames, door-handles, walking-sticks, chessmen, handles of swords and knives, buttons, combs, flutes, &c. &c.

By the admixture of sulphuric acid, or of a tenth or larger part of vegetable wax or tallow, any degree of solubility, pliancy and softness may be acquired: or the composition may be used as varnish, to cover other materials, concealing any odor, and imparting a surface, impervious to water. In printing and painting of silk or cotton, it seems applicable to many uses, for it amalgamates readily with colors; when interposed between two thin sheets of gold leaf or tin foil, it combines them firmly in one.

Numerous are the purposes to which Mr. Hancock proposes applying the *Gutta Percha;* but the above-named may suffice for our readers.

Gutta Percha.—E. Soubeiran; (Journ. de Pharm. et de Chim., Jan., 1847.)—The chemical relations of Gutta Percha are almost identical with those of caoutchouc. Separated from impurities by hot water, and from the accompanying resins by alcohol and ether, the substance was obtained in a state of purity by Soubeiran. Submitted to analysis, it gave carbon 87·8, hydrogen 12·2; while according to Faraday, caoutchouc gave carbon 87·2, hydrogen 12·8.

The action of solvents is also similar with the two substances. Water and alcohol have no effect: ether and most volatile oils produce only imperfect solution. The true solvent is oil of turpentine, which produces a clear and colorless solution, from which the Gutta Percha may be obtained unchanged, by evaporation.

The specific gravity of Gutta Percha is 0·9791, that of caoutchouc being 0·9355.

Prolonged exposure to a temperature of about 300°, produces translucence and a deeper gray color; but hot or cold water gradually restore the primitive appearance.

An application suggests itself to us which we have not as yet seen mentioned. We refer to its use as a substitute for cork and other materials for air-tight closure of chemical vessels, through which tubes, &c. are to be passed. There is no doubt that in the hands of the chemist, this substance will soon become one of his most valuable materials.

3. *Smelting Copper Ore.*—There are establishments for smelting copper at Boston and at Baltimore. At Boston the smelters have long been extensive refiners and manufacturers of copper, and they manufacture the product of their smelting works. At Baltimore the ores have been chiefly obtained from Cuba; at Boston, principally from Cuba and Chili. The Swansea (Welsh) method of smelting, with reveberatory furnaces, both for calcination and reduction, has been adopted, but they use equal parts of anthracite and bituminous coal. At Boston, the German method, with calcination in the open air, and reduction in the small upright blast furnace, with anthracite coal alone, is preferred. In Baltimore they have six or eight furnaces in operation, with an experienced manager from Swansea. In Boston the arrangements are on a much more extended scale. Freights from Cuba to Boston or New-York are much lower than from Cuba to Wales. It is suggested that the best method for smelting would be, as in England, to carry the ores to the coal. What is the nearest place to the mines on Lake Superior, where there are anthracite coal mines? It is estimated that a ton of anthracite coals will reduce two tons of 20 per cent. ore. About $55 are paid per ton, at Boston, for 20 per cent ore; freights from Cuba are over $6, and from Chili $15. We publish at page 276, an account of the process of smelting copper ores by means of electricity—a process which, however, cannot with any propriety be called smelting. It might more properly be called the reduction of copper by the wet method.

4. *On the Formation of Cylindrical Masses of Snow in Orkney.*—(A letter from Charles Clouston, dated Sandwick Manse by Stromness, Feb. 11th, 1847, to Richard Taylor, Esq., published in Lond., Edin. and Dub. Phil. Journ., April, 1847, p. 301.)

The following notice derives an additional interest from the circumstance that a similar phenomenon was described twenty-seven years ago, in this Journal, vol. ii, p. 132, by the late Rev. Daniel A. Clarke, as having occurred in Morris Co., New Jersey, in January, 1808. The author of this notice in describing the circumstances to me in the year 1825, remarked that he was led to consider the phenomenon as one of singular peculiarity, as the description of it by himself had

the ill fortune to be treated very frequently with much incredulity. It will be interesting for the reader of the following remarks, to recur to Rev. Mr. Clarke's notice, since what in the one case is a matter of conjecture as to the origin of the cylinders, will be found in the other, to be a subject of direct observation. C. U. SHEPARD.

"A curious phenomenon in this parish has astonished and perplexed all, and filled the superstitious with no small degree of consternation. Since the 6th inst., we have had hail or snow-showers, on the 9th snow-drift, and yesterday a slight thaw with frost again in the evening.

"During the night a heavy fall of snow took place, which covered the plain to the depth of several inches. Upon this pure carpet there rest thousands of large masses of snow which contrast strangely with its smooth surface. A solitary mass may be seen in a field, but in general they occur in patches from one acre to a hundred in extent, while the clusters may be half a mile asunder, and not one mass to be seen in the interval. These fields appear at a distance as if cart-loads of manure had been scattered over them and covered with snow, but on examination the masses are all found to be cylindrical, like hollow fluted rollers or ladies' swan-down muffs, of which the smaller ones remind me, from their lightness and purity, but most of them are of much greater dimensions and weight than any lady would wish to carry, the largest that I measured being three and a half feet long and seven feet in circumference. The weight however is not so great as might be expected from the bulk; so loose is the texture, that one near this house which was brought in and weighed, was found to be only sixty-four lbs., though it measured three feet long and six and a half feet in circumference. The centre is not quite hollow, but in all there is a deep conical cavity at each end, and in many there is a small opening through which one can see, and by placing the head in this cavity in the bright sun, the concentric structure of the cylinder is quite apparent. So far as I am yet informed, they do not occur in any of the adjoining parishes, and they are limited to a space of about five miles long and one broad. They may occupy about 400 acres of this, and I counted 133 cylinders in one acre, but an average of a hundred would, at a rough computation, yield a total of about 40,000.

"Now the question naturally arises, what is the origin of these bodies? I believe the first idea was that they had fallen from the clouds, and portended some direful calamity, and I hear an opinion that one had fallen on a corn-stack and been broken to pieces. It is a pity to bring down such lofty imaginations, and to deprive these cylinders of their high descent, but I prefer truth, when it can be discovered, to the loftiest theory. I must at once, then, set aside the idea that they fell from the atmosphere in their cylindrical form, as the first one I examined satisfied me that its symmetry and loose texture must have been immediately destroyed in coming in rude contact with this earth.

"Farther observation has convinced me that they have been formed by the wind rolling up the snow, as boys form large snow-balls. This is proved by examination of the *bodies themselves;* their round form, concentric structure, and fluted surface all show this mode of formation. Again, it is proved by their *position:* none are found on the weather side of hills or steep eminences, where the wind could not drive them

up, nor close to leeward of any wall or perpendicular bank from which they seem to have originated—the nearest well-formed small ones being sixty yards to leeward, and the large ones one hundred yards. All nearer than this are fragments that have not gone on to completion, but broken down in their passage, and the different portions of the wreck form the nuclei of others. Many however are found blown to the windward side of walls or over the lee side of banks. Indeed, they are found almost exclusively on the leeward side of hills and eminences, where both the wind and declivity assisted in rolling them along, or on plains so exposed that the wind alone operated without the declivity.

"I shall only add, that this mode of formation is proved by the *direction* in which these cylinders lie. The wind has been from the north for four days, and I believe that it was so all night, when I am told it blew strong. Now they are all lying with their ends east and west, and their side to the wind; and farther, in some cases, their tracks are still visible in the snow for twenty or thirty yards on the north side, from which they have gathered up their concentric coats; and I understand these were still more evident at an early hour before a snow-shower obliterated them in many places."

5. *Arts and Sciences at Harvard.*—In our last number mention was made of the munificent donation of Mr. Abbott Lawrence of Boston, towards establishing a school of Practical Science at Harvard. On account of the great importance of the plan proposed, and the able manner in which the subject is presented, we republish from the Boston Courier, the letter of Mr. Lawrence accompanying his donation, addressed to the Hon. Samuel A. Eliot, Treasurer of Harvard College.

"*Dear Sir*,—I have more than once conversed with you upon the subject of establishing a school for the purpose of teaching the practical sciences, in this city or neighborhood; and was gratified when I learned from you that the government of Harvard University had determined to establish such a school in Cambridge, and that a Professor had been appointed who is eminent in the science of Chemistry, and who is to be supported on the foundation created by the munificence of the late Count Rumford.

"For several years I have seen and felt the pressing want in our community, (and in fact in the whole country,) of an increased number of men educated in the practical sciences. Elementary education appears to be well provided for in Massachusetts. There is, however, a deficiency in the means for higher education in certain branches of knowledge. For an early classical education we have our schools and colleges. From thence the special schools of Theology, Law, Medicine and Surgery, receive the young men destined to those professions; and those who look to commerce as their employment, pass to the counting house or the ocean. But where can we send those who intend to devote themselves to the practical applications of science? How educate our engineers, our miners, machinists and mechanics? Our country abounds in men of action. Hard hands are ready to work upon hard materials; and where shall sagacious heads be taught to direct those hands?

"Inventive men laboriously reinvent what has been produced before. Ignorant men fight against the laws of nature with a vain energy, and

purchase their experience at great cost. Why should not all these start where their predecessors ended, and not where they began? Education can enable them to do so. The application of science to the useful arts has changed, in the last half century, the condition and relations of the world. It seems to me that we have been somewhat neglectful in the cultivation and encouragement of the scientific portion of our national economy.

"Our country is rapidly increasing in population and wealth, and is probably destined in another quarter of a century to contain nearly as many inhabitants as now exist in France and England together.

"We have already in the United States a large body of young men who have received a classical education, many of whom find it difficult to obtain a livelihood in what are termed the learned professions. I believe the time has arrived when we should make an effort to diversify the occupations of our people, and develop more fully their strong mental and physical resources, throughout the Union. We have, perhaps, stronger motives in New England than in any other part of our country, to encourage scientific pursuits, from the fact that we must hereafter look for our main support to the pursuit of commerce, manufactures, and the mechanic arts; to which it becomes our duty, in my humble judgment, to make all the appliances of science within our power. We inherit, and are forced to cultivate a sterile soil; and what nature has denied, should be as far as possible supplied by art. We must make better farmers, through the application of chemical and agricultural science.

"We need, then, a school, not for boys, but for young men whose early education is completed, either in college or elsewhere, and who intend to enter upon an active life as engineers or chemists, or in general, as men of science, applying their attainments to practical purposes; where they may learn what has been done at other times and in other countries; and may acquire habits of investigation and reflection, with an aptitude for observing and describing.

"I have thought that the three great practical branches to which a scientific education is to be applied amongst us, are, 1st, Engineering; 2d, Mining, in its extended sense, including meteorology; 3d, the invention and manufacture of machinery. These must be deemed kindred branches, starting from the same point, depending in many respects on the same principles, and gradually diverging to their more special applications. Mathematics, especially in their application to the construction and combination of machinery, and chemistry, the foundation of knowledge and an all-important study for the mining engineer, and the key to the processes by which the rude ore becomes the tenacious and ductile metal. Geology, mineralogy, and the other sciences, investigating the properties and uses of materials employed in the arts, carpentry, masonry, architecture and drawing, are all studies which should be pursued to a greater or less extent in one or all of these principal divisions.

"To establish such a school as I have endeavored to describe in connection with the University, and under the care and general guidance of its government, requires buildings with suitable lecture-rooms and philosophical apparatus, with models and plans, and a place for their deposit and safe keeping, together with a *Cabinet*, where every de-

scription of wood, ores, metals, &c. &c., may be deposited for the use of the students. Without the above appliances the professors would be workmen without tools. The University has already appointed Mr. Horsford, Rumford Professor, who proposes to give instruction upon an enlarged plan in the science of chemistry. I have often heard Professor Horsford spoken of in terms of high commendation, and as in all respects competent to take charge of this important department of science, and to bring out the most favorable results. The testimony rendered at home to Mr. Horsford's capacity has been very agreeable to me, and had satisfied me that the selection made by the government of the college was fortunate; but I have lately learned in addition to the high character given him by his friends here, that the great practical chemist of the age, (Liebig,) has given his most unqualified testimony to the ability and fidelity of Professor Horsford, who was the pupil of Baron Liebig for two years.

"I deem it of the highest importance, and in fact essential, that none but *first rate* men should occupy the Professors' Chairs in this School. Its success depends upon the characters of the instructors. They should be men of comprehensive views, and acknowledged talents, possessing industry and integrity, with an enthusiastic devotion to the great interests of science. They should love their profession, and work in it day by day. Such teachers will soon gather around them a large number of pupils.

"To carry out this course of education in its practical branches, there should be the most thorough instruction in engineering, geology, chemistry, mineralogy, natural philosophy, and natural history. Chemistry is provided for, and in the last two branches, instruction might perhaps be given by the present College Professors. In addition to these, it would be necessary to obtain the services at stated periods of eminent men from the practical walks of life. The law school is taught by distinguished lawyers of the highest reputation. The medical school by distinguished physicians. In like manner, this school of science should number among its teachers men who have practiced, and are practicing the arts they are called to teach. Let theory be proved by practical results.

"To defray the expenditures, means must be procured for the erection of suitable buildings, (not including dwelling houses) the purchase of apparatus, furniture, &c. &c., and provision must be made for the comfortable support of the professors and other teachers employed. For this purpose, let the students be invited freely from all quarters, at a moderate charge for tuition. Let the numbers be only limited by the size of the lecture-rooms, and I cannot entertain a doubt that a large revenue would be derived from tuition fees. I would suggest three permanent professors, viz: one of chemistry (already appointed), one of engineering in its various branches, and one of geology. The support of the first is for the present provided for. For the other two a moderate fund must be obtained, as a nucleus of a farther sum which should be added to it, to make the capital equal to that of the Rumford Professorship. The professors in this school should depend, to a considerable extent, upon fees: it is the best guaranty to exertion and fidelity, and the permanent prosperity of the institution. I will, therefore, further suggest, that each of the above professors shall receive, after

all ordinary expenses shall have been paid, one half of the tuition fees till they amount to a sum annually not exceeding three thousand dollars, including their stated salaries; and that the government of the college pay such sums to other teachers, whether temporary or permanent, as they may deem expedient, and that the other half of the said tuition fees be reserved and added to any fund that may be hereafter contributed to establish and found the two professorships before mentioned.

"I have now, my dear sir, given you a brief and very imperfect sketch of such a school of science as I believe the condition of our extensive and growing country requires, and you will ask how the means are to be obtained to carry out the plan, when we shall soon have an appeal made to our liberality, as well as to the sense of our best interests, to contribute a large sum of money for the purpose of finishing the astronomical department so auspiciously commenced in Cambridge. This department of science has already engaged the public sympathy, and will, I doubt not, be taken up at an early day, and placed in an independent and useful position. I cherish a wish to see the observatory, the telescope, and every instrument required to prosecute the heavenly science, ready for use, and do not intend to interfere with the claims the world has upon our community to accomplish this great and important object. Nor do I mean to occupy the ground of another branch of science that will, I suppose, at a future time, present strong claims upon the public bounty. I allude to natural history now in charge of that accomplished naturalist, Dr. Gray. I wish to see all these branches of science prosecuted with vigor, and moving forward in perfect harmony at Cambridge.

"I therefore propose to offer, through you, for the acceptance of the President and Fellows of Harvard College, the sum of fifty thousand dollars, to be appropriated as I have indicated in the foregoing remarks. The buildings, I have supposed, without having made estimates, could be erected, including an extensive laboratory, for about thirty thousand dollars. If so, there will remain the sum of twenty thousand dollars; and I suggest, that whatever sum may remain, after the erection and furnishing of the buildings, should form the basis of a fund, which, together with one-half of the tuition fees, till the amount shall yield the sum of three thousand dollars annually, shall be equally divided between the professor of engineering and the professor of geology, and be made a permanent foundation for these professorships. The object is, to place the three professors in this school in the same pecuniary situations. I beg to suggest further, that the whole income of this school be devoted to the acquisition, illustration, and dissemination of the practical sciences forever.

"The details, however, and conditions of this donation, may be hereafter arranged between the Corporation and myself. I now leave the whole subject in the hands of the gentlemen composing the Corporation, in the hope and faith that the plan may be adopted, and executed with as much expedition as may be consistent with economy; and that it may prove to be honorable to the University, and useful to the country.

"I pray you, dear sir, to believe I remain, most faithfully, your friend, ABBOTT LAWRENCE."

Boston, June 7, 1847.

6. *On some New Researches in Animal Chemistry*, (extracted from a letter from Professor LIEBIG to Dr. A. W. HOFMANN, Phil. Mag., xxx, 412, June, 1847.)—I am at present occupied with the investigation of the constituents of the animal fluids which are found without the blood and lymphatic vessels. The fluid from flesh, for example, reacts strongly acid, and the question was, whence arose this acidity? After overcoming more difficulties than I have ever experienced in any investigation, I have for the first time indisputably proved that free lactic and phosphoric acid exist in the whole organism wherever muscle is found. How curious, that in the absence of all proofs on the part of the opponents of lactic acid, I should now demonstrate to them its existence in the flesh of oxen, fowls, calves, and sheep, by preparing and analyzing the most beautifully crystallized zinc and lime salts! How wonderful, that in the animal organism, acids and alkalies are found separated by a membrane, constituting myriads of little galvanic circles, which, as such, must produce chemical and electrical effects! To the latter class I refer all the observations of Matteucci, which can now be easily explained.

I have further found that the flesh of the muscles of oxen, fowls, sheep, calves, and the carnivorous pike, contain creatin, prepared by Chevreul eleven years ago, and which, from Berzelius's not being able to reproduce it, has since then, in a measure, disappeared from the field of science. Creatin is a beautiful substance, having the formula $C_8N_3H_{11}O_6$. At the temperature of 100° C. it loses 2 equivs. of water, and becomes $C_8N_3H_9O_4$ = glycocoll + ammonia or caffein + amidogen and water. Heated in a stream of hydrochloric acid, creatin loses four equivs. of water and takes up one of hydrochloric acid. By this treatment, however, its nature is entirely altered, being now converted into a beautiful organic base, the properties of which are totally different from those of creatin. It becomes now soluble in water, and forms with bichlorid of platinum a fine crystallized double salt.

I have, finally, discovered two other new bodies in the same fluids, of which one crystallizes in needles, the other in plates of the lustre of mother-of-pearl. Unfortunately, I have obtained scarcely sufficient for two analyses from forty lbs. of the flesh of oxen and twenty of that of fowls.

I see a boundless field before me, and doubt not that for every *quality* of the animal body, something which can be estimated *quantitatively*, will also be discovered to which it is indebted for its properties.

I have also satisfied myself as to the part which common salt plays in the bodies of animals. I have found that the fluids without the blood and lymphatic vessels contain only potash-salts, viz. chlorid of potassium and phosphate of potash, with phosphate of magnesia, whilst the blood and lymph contain merely those of soda, (phosphate of soda.) If, therefore, the latter are indispensable to the formation of blood and the processes of life, it is evident that an animal on the continent, which finds in plants only potash-salts, should have chlorid of sodium given to it, by means of which the phosphate of potash of the seeds and the rest of the plant is transformed into chlorid of potassium and phosphate of soda. I found further that the salt brine which flows from salted meat contained certainly alkaline phosphates, and that scurvy is hence easily

explained by the deficiency in the salted meat of the alkaline phosphates necessary to the formation of blood. The soup from boiled meat contains the soluble phosphates of the flesh, and the meat itself the insoluble. Neither the soup nor the flesh alone can maintain the processes of life, but both must be taken together. The English have in this respect hit upon the proper practice. In a theoretical point of view their food is more correctly combined than that of the Germans.

Still more wonderful results have been obtained by the oxydation of casein by means of peroxyd of manganese and sulphuric acid, by M. Gugelberger. Three products are obtained: the first of which is aldehyde, the second oil of bitter almonds, and the third a fluid ethereal body with a composition similar to metacetone. The aldehyde was analyzed as aldehydite of ammonia, of which a considerable quantity was obtained. From oil of bitter almonds the most beautiful benzoic acid was produced by the action of chlorine.

From these results a sort of conception may be obtained how and wherefore many medicines have a certain deleterious or useful action.

Urea, creatin, glycocoll, leucin, cystin, &c., are organic bases, and only products of the animal body or its elements, and organic bases are partly poisonous, partly beneficial in their action. I have caused the new experiments of Mulder on his protein to be repeated. The substance prepared by Fleitmann in this laboratory, according to his new method, and supposed to be free from sulphur, still contains 1·5 per cent., as does likewise a similar preparation by Laskowski.

7. *Palæontographical Society of London.*—The Palæontographical Society has been instituted the present year, and as organized, Sir Henry T. De La Beche, is President, and Prof. Bell, Prof. Forbes, Charles Lyell, Esq., Prof. J. Phillips, and other men of distinction are the Council.

From the Prospectus we observe that it is the object of the Society to figure and describe as complete a stratigraphical series of British fossils as can be accomplished, including both the published and the unpublished species. It is proposed that the work shall be quarto, and that each plate shall, on the average, contain about twenty figures, illustrating half as many species, or more, according to circumstances. The work will be produced in the form of monographs, by various authors. As a commencement of the series, the whole of the British tertiary fossils are in course of being described and figured, under the superintendence of Mr. Searles Wood, Mr. F. E. Edwards, Mr. Flower, Mr. Smith, of Jordan Hill, and other gentlemen of well known geological experience. No precise order of publication will be adhered to, but it is proposed that monographs of portions of the secondary series shall also be produced as early as the nature of such undertakings will permit. The copper-plates are being executed by the Messrs. Sowerby, and other artists of eminence in this department of engraving.

Calculations have been carefully made, which show, that if 1000 members be acquired, and 1250 copies be printed, sixty plates and letter-press may be given annually to each member for his subscription of £1 1*s*.

8. Obituary.—*Ithamar B. Crawe*, M.D., of Watertown, was *drowned* in Perch Lake, Jefferson Co., N. Y., June 2, 1847. Suddenly called from life, he was deeply lamented by the public and affectionately mourned by his particular friends. He fell a sacrifice to his ardor in the pursuits of natural history. In the study of geology, mineralogy and botany, he had long been successfully engaged, and had accumulated a rich treasure of specimens in these departments, while he had made himself by his own discoveries and by exchanges, the friend of many of the naturalists of our country and of Europe. He was returning from a successful botanical excursion in a *leaky* boat, which sunk; and thus was closed his valuable life, when he had nearly attained the age of fifty-four years. A wife and three children receive the cordial sympathies of numerous friends over the land.

Dr. Crawe was born in the state of Connecticut, and was descended from one of the Pilgrim fathers of Plymouth rock. His father was a soldier in our revolution, a man of sterling integrity and firmness. The son inherited these manly virtues, and distinguished himself in his profession and pursuits. At the close of his medical studies, he received his diploma from the hand of Dr. Mott. He settled in Watertown soon after his graduation, and, having made it his residence most of the time since, he had endeared himself to a wide circle of his fellow citizens, who have given public evidence of their high estimation of his worth and attainments in his profession and in those studies to which he gave the strong powers of his mind. To that part of the state his loss is a source of public sorrow; to us all deeply afflictive. C. D.

Rochester, N. Y., June, 1847.

VI. Bibliography.

1. I. *Geology: Introductory, Descriptive, and Practical.* II. *The Ancient World, or Picturesque Sketches of Creation.* By D. T. Ansted, M.A., F.R.S., F.G.S., Professor of Geology in Spring's College, London, &c. &c.

The geological works of Prof. Ansted have been for some years before the world. The Geology was published in 1844, in two beautiful 8vo volumes, of more than 1000 pages. It is divided into three parts.—I. Introductory. II. Descriptive Geology. III. Practical Geology.

I. The Introduction, in four chapters, explains the object of the work, the action of present causes, the classes of rocks and the powers concerned in their production, the nature and value of fossils and of Palæontology, and of the results which it affords.

II. The Second Part, in forty-eight chapters, describes, 1. The fossiliferous or stratified rocks—under the heads of the older and the newer Palæozoic period. The secondary period. The Tertiary period. II. The description of crystalline and unstratified rocks.

III. The Third Part, in seventeen chapters, describes Practical Geology, with its applications to mining, engineering, architecture, agriculture, &c.

The practical geology occupies more than half of the second volume.

These volumes are illustrated in all, by three hundred and sixty-seven figures. The illustrations are all done on wood, and being executed with great skill and carefully copied upon the printed page of the most beautiful paper, they are at once effective for instruction and highly ornamental.

This work contains a lucid and judicious summary of the facts of the science, with cautious indulgence in theory. We perused it soon after it appeared, and with much instruction and pleasure: nor have we remained silent regarding it from any want of a just appreciation of its merits. We have not observed Prof. Ansted often among the active explorers of geology with whom Great Britain abounds; but he has proved himself to be a very diligent student of the science, and one of its attractive and successful historians. His learned and elegant work we can therefore recommend to the student of geology as an important addition to his library. It is worthy of a much fuller review and analysis; but as much time has elapsed since its appearance, and it has been extensively noticed in other journals, we now hasten to his very recent work,

II. *The Ancient World*, named at the head of this article. The first thing that struck us a month since, on the opening of the package from London, was, that a volume had actually dropped down upon us from the ancient world, and that it is quite a mistake that the art of printing is only four hundred years old.

In strict keeping with its subject, the covering and external adornments of the volume are in a style of ultra antiquity, while its interior presents fine paper, the best typography, and finished illustrations in one hundred and forty-seven wood-cuts, besides two vignettes—one of which is a restoration of the vegetation of the cold period as it existed at that era in England.

The volume is in the form of a large duodecimo of more than four hundred pages. It is divided under three periods:

The First, or Ancient Epoch; the Second, or Middle Epoch; and the Third, or Modern Epoch.

There are in all sixteen chapters; and (1.) an Introductory chapter unfolds the general structure and physical laws of the planet.

Under the first epoch the principal subjects are presented in the following order:

2. The period of the prætzoic, or non-fossiliferous or primary rocks.
3. That of the invertebratæ and Silurian rocks.
4. Early fishes and Devonian rocks, or the old red sandstone.
5. Earliest terrestrial plants and the era of coal.
6. The magnesian limestone, or Permian system.

Under the second epoch:

7. The new red sandstone, or Triassic system.
8. Lias and marine reptiles.
9. Wealden and land reptiles, and flying reptiles, &c.
10. The Cretaceous period, with its animals.
11. General considerations on the secondary epoch and its termination.

Under the third epoch:

12. The introduction of land animals, and the early tertiary.

13. Europe, between the early tertiary and the historic period.
14. India, Australia, and New Zealand, during the tertiary period.
15. South America in the same era.
16. General results of geological investigations.

If then our readers are disposed to enquire for the *cui bono?* of the present work, the answer shall be given by the author himself in his Preface, which has the rare excellency of brevity as well as truth and candor. "The object of this work is to communicate, in a simple form, to the general reader, the chief results of Geological Investigation. No detailed account of particular districts, no minute statements with regard to peculiarities of structure, exhibited in various formations, or in their fossil contents, must therefore be expected; and on the other hand, the reader will be spared as far as possible, the mere technicalities of the science, while being informed of the views deduced from the study of them. The author hopes that if in thus endeavoring to communicate definite ideas concerning the ancient history of the earth and its inhabitants, he shall be found not to express with perfect accuracy, the whole amount of what is known in any department of geological science, his attempt may yet be viewed favorably, as a fair sketch of such history, at least in its broad outlines."

An attentive perusal of Prof. Ansted's work, satisfies us that he has ably fulfilled his own views. He has produced an attractive and valuable volume, in which he has posted up the most recent discoveries, and presented also some peculiar views of his own, differing in some respects from those generally received.

2. *Natural Philosophy for the use of Schools and Academies, illustrated by numerous Examples and appropriate Diagrams;* by HAMILTON L. SMITH, A.M. Cleveland, Ohio, 1847. 12mo, pp. 352.

This is a very meritorious production, marked by sagacity and sound science. Designed for the purposes of elementary instruction, it claims no other merit than that of a successful inculcation of the established principles of natural philosophy: and this merit it possesses. The author has a happy faculty of presenting his subject in an attractive and lucid form, and the method of the book is very well suited to the object in view. He is obviously familiar with the present state of his science, and teaches only a selection of his knowledge. Only one who is thoroughly acquainted with a science, is able to write a useful elementary work upon it. No notion is more absurd, than that one who knows little of a subject is fit to write books for those who know nothing. Such is not our present author.

3. *Hints to Young Architects, calculated to facilitate their Practical Operations;* by GEORGE NIGHTWICK: and with Additional Notes to persons about building in the Country; by A. J. DOWNING. New York and London. Wiley & Putnam: 1847. 8vo, pp. 157.

Mr. Downing has established so desirable a reputation in all that relates to rural life and domestic architecture, that his works have become standards not only in this country, but in Europe also. The object of the present work is purely practical, and it contains much useful information and specific detail of construction for those about to build. The American editor has added among other things a well written introductory chapter, entitled, "When to build, what to build, and how

to build," which unfolds in an attractive form, the principles of good taste and good sense involved in these considerations. The book will be well appreciated by all who are about to indulge their architectural taste, as well as by professional architects.

P. H. Gosse: The Birds of Jamaica. Post. 8vo. *London*, 1847. 10*s*.

D. T. Ansted: The Ancient World, or Picturesque Sketches of Creation; Post. 8vo, with 149 illustrations. *London*, 1847. 12*s*.

Taylor's Scientific Memoirs. Part 17. Containing Schmidt's Contributions to the Comparative Physiology of the invertebrata, being a Physiologico-chemical investigation; Fresnel on the colors produced in homogeneous fluids by polarized light; Jamin on Metallic Reflection; Dove's Researches on the Electricity of Induction.

Transactions of the Entomological Society of London, 4th part of 4th volume. 5*s*. The 5th part, completing the volume, will shortly appear.

Report of the Sixteenth Meeting of the British Association, London. 15*s*.

Catalogue of 47390 stars for the beginning of the year 1800, from the observations of Lalande in the Histoire Celeste; reduced at the expense of the British Association for the Advancement of Science, under the immediate superintendence of the late Francis Bailey, Esq. *London*, 1847.

Catalogue of 9766 stars in the Southern Hemisphere for the beginning of the year 1750, from the observations of the Abbe de Lacaille, made at the Cape of Good Hope in the years 1751, 1752; reduced at the expense of the Brit. Assoc. under the superintendence of the late Prof. Henderson. *London*, 1847.

G. Johnston, M.D.: History of British Zoophytes. 2d ed. *London*, 1847, 8vo, 2*l*. 2*s*.; or large paper, royal 8vo, 4*l*. 4*s*.

H. C. Watson: Cybele Brittanica; or British Plants and their Geographical Relations. 8vo. *London*, 1847.

G. Munby: Flore de l'Algérie. pp. 120. 6 pl. *Paris*, 1847.

W. Engelmann: Bibliotheca Historico-Naturalis; Verzeichniss der Bücher über Naturgeschichte welche in Deutschland, Scandinavien, Holland, England, Frankreich, Italien und Spanien, in den Jahren 1700–1846 erscheinen sind. 8vo. *Leipzig*, 1847. Erster Band.—A work of great value.

J. Berzelius: Jahresbericht über die Fortschritte der Chemie u. Mineralogie. Translated from the Swedish. Gr. 8vo. *Tubingen*, 1847.

F. Kolenati: Meletemata Entomologica fasc. iii. and iv. (Caucasian insects.) Large 8vo, with 6 plates. *Petersburg* (Lipsiæ, Voss). 1847.

P. F. de Siebold: Fauna Japonica Pisces elaborantibus C. J. Temminck et H. Schlegel. Decas xiii–xv, gr fol. *Lugduni Batavorum*, 1847.

Proc. Amer. Philosophical Society, Philadelphia, iv, No. 38. *April*, *May* and *June*, 1847.—p. 327. On the reproduction of the Didelphis virginiana; *C. D. Meigs*.—pp. 332, 339. On the planet Neptune and its identity with the Lalande star; *S. C. Walker*.

Proc. Acad. Nat. Sci. of Philadelphia, iii, No. 9. *May* and *June*, 1847.—p. 210. Numerous minute crystals in the cellular structure of several species of Parmelia, supposed to be oxalate of lime; *J. Leidy*.—p. 212. Remarks on an aboriginal cranium from the Western Mounds; *S. G. Morton*.—p. 216. Hydrarchus of Dr. Koch acknowledged by Prof. Müller of Berlin to be the Basilosaurus of Harlan and Zeuglodon of Owen.—A cutaneous gland near the root of the tail of the Fox emitting an agreeable odor, detected by Prof. Retzius, and considered by him characteristic of the genus Vulpes.—p. 220. Distoma Helicis, a new Entozoon from a Helix; *J. Leidy*.—p. 221. Observations on a Mexican Quail, the Ortyx squamata; *J. W. Abert*.

Proc. Boston Society of Nat. History, *March*, *April*, 1847.—pp. 210, 214, 222. Descriptions of Shells of the Exploring Expedition, (genera Ancylus, Dombeya, Limnea, Planorbis, Physa, Melania); *A. A. Gould*.—p. 217. Observations on some analyses of snow.—p. 218.—*Dr. C. T. Jackson* exhibited beautiful crystals in cinders from the copper works at Point Shirley, which proved on analysis to be a bisulphate of Copper and Zinc.—Dr. Jackson described an interesting experiment of Mr. Blake at the gas-works, as follows:—"He placed a mass of compact feldspar in a crucible, hermetically sealed, in a furnace flue at the gas-works, where it was exposed for 108 hours to a uniform temperature considerably below the degree

necessary for the fusion of the mineral. On being taken out, it was found to be perfectly limpid, and as transparent as quartz: showing that long continued heat, though not to a degree sufficient to melt the mineral, produces effects similar to those resulting from fusion."—p. 218. New shells from Burmah (Gen. Melania, Neritina, Nerita, Nematura, Unio); *A. A. Gould.*

Ann. and Mag. of Nat. History, *Vol.* xix, *No.* 127, *May*, 1847. Formation of Flints; *J. T. Smith.*—British shells; *J. G. Jeffreys.*—On the Genus of Insects *Omias*, with descriptions of new species; *J. Walton.*—Development of the Lycopodiaceæ; *K. Muller.*—Silurian rocks in Cornwall; *R. I. Murchison.*—Invertebrata of the coast of Northumberland and Durham; *W. King.* Linnæan Society: *D. Hooker* on the vegetation of the Galapagos; *G. B. Sowerby*, on a new Cowry; *G. Newport*, Anatomy, &c. of Meloë. Zoological Society: *J. Gould*, on new Australian Birds.—*J. E. Gray* on a new rat from South Australia; *G. R. Gray*, on new genera of Certhinæ.

No. 128, *June*, 1847. On Chelura terebrans, an amphipodous crustacea; *G. J. Allman.*—Ornithological Notes; *J. Blackwall.*—New British Coleoptera; *J. Hardy.*—New Labyrinthi-bronchial fish from Quellimane; *W. Peters.*—New Lepidoptera; *E. Doubleday.*—A species of Pelagia in the British Seas.—New Chalcidites from N. America; *F. Walker.*—Two new genera of shells; *Philippi.*—Zoolog. Soc. *J. Gould's* arrangement of Trochilidæ, with descriptions of some new species; *J. E. Gray*, on six new genera of Bats; *A. Adams*, on certain molluscous animals; *L. Reeve*, new shells from the Eastern Archipelago; *T. Bridges* on S. American Ornithology; *A. D. Bartlett* on a new Fuligula.

No. 129, *July*, 1847. Development of the Ophiuridæ and Echinidæ; *J. Müller.* New species of insects of the genus Otiorhynchus; *J. Walton.*—Linnæan Society: *Dr. Falconer*, on Gamoplexis, a new genus of Orchideous plants; *L. Reeve*, on the structure, &c., of Chiton and Chitonellus; *W. Griffith* on the impregnation of Dischidia; *Dr. Arnott* on Samara læta, L.; *G. Newport* on Cryptophagus cellaris.—Zool. Soc. *J. Gould*, on eight new Australian Birds; *J. E. Gray*, on a new Amphioxus from Borneo; *W. Denny*, on the Geographical Distribution of Birds in the W. Indies; *J. E. Gray*, on the skull of Phascolomys vombatus.

Vol. xx, *No.* 130, *July*, 1847. New genus and species of Entomostraca; *G. J. Allman.*—On conjugation in the Diatomaceæ; *G. H. K. Thwaites.*—Canada Plants; *P. W. Maclagan.*—Two Asiatic species of Carabus; *T. Tatum.*—Notices of British Shells; *J. G. Jeffreys.*—New Chalcidites of N. America; *F. Walker.*—Plants of Iceland; *C. C. Babington.*—On the power of the living plant to restrain the evaporation of the cell sap; *H. v. Mohl.*—On the relative duration of the power to germinate in seeds belonging to different families; *A. DeCandolle.*—New genus and species of Tracheary Arachnidans; *G. J. Allman.*—Zool. Soc.: Notices of rare birds of N. Zealand and Australia; *W. Yarrel*, on the Eggs of some of the birds of Chili; *J. E. Gray*, on a new genus of Emydæ; *A. White*, on new Crustacea from the Eastern Seas; *E. Doubleday*, on new Lepidoptera; *G. R. Gray*, on Strigops habroptilus; *J. E. Gray*, on the genera of the family Chitonidæ.

Archiv für Naturgeschichte. *Fünftes Heft*, 1846.—On the Acanthocercus rigidus, a new Entomostraca of the group Cladocera; *J. E. Schödler.*—General review of Works and Memoirs on Insects, Spiders and Crustacea, for the year 1845; *W. F. Erichson.*

Erstes Heft, 1847. On the organ of the Sepia having the function of the kidney; *E. Harless.*—Zur Lehre von der Furchungen; *A Kölliker.*—On the Sepiola vulgaris; *R. Leuckart.*—On Tiedmannia, Octopodoteuthis and Alciopa; *A. Krohn.*—On the family Ecpleopoda; *J. J. v. Tschudi.*—Two new genera of shells, Dibaphus and Amphichæna, with remarks on Cyamium, Ervilia and Entodesma; *R. A. Philippi.*—Peruvian Coleoptera; *G. F. Erichson.*

ASSOCIATION OF AMERICAN GEOLOGISTS AND NATURALISTS.

The 9th Annual Meeting of this Association, will be held pursuant of adjournment, at Boston, during the week commencing September 20th.

A large and interesting meeting is expected.